NOTICE

All drawings located at the end of the document.

DRAFT

TECHNICAL MEMORANDUM NO. 1
TO THE FINAL RFI/RI WORK PLAN:
OPERABLE UNIT NO. 3

ROCKY FLATS PLANT

U.S. DEPARTMENT OF ENERGY
Rocky Flats Plant
Golden, Colorado

ENVIRONMENTAL RESTORATION PROGRAM

April 23, 1993

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LIST OF TABLES

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LIST OF ACRONYMS AND ABBREVIATIONS

The following is a list of acronyms and abbreviations used throughout this work plan TM.

acfm	actual cubic foot per minute
Am	americium
ASTM	American Society of Testing and Materials
°C	degrees Centigrade or Celsius
CDH	Colorado Department of Health
cfm	cubic feet per minute
cm	centimeters
COC	chemicals of concern
DCNs	Document Change Notices
DOE	United States Department of Energy
DQI	Data Quality Indicator(s)
DQO	data quality objective
EE	Environmental Evaluation
EMD SOP	Environmental Management Department Standard Operating Procedures
EPA	United States Environmental Protection Agency
FSP	Field Sampling Plan
ft	foot/feet
g/m^2	grams per square meter
g/m^3	grams per cubic meter
hi-vol	high volume
in	inches
l/s	liters per second
m	meter
m^2	square meter
m^3	cubic meter
m^3/hr	cubic meters per hour
m^3/s	cubic meters per second
mg	milligrams
µm	micrometers
µmA	micrometer amps
MMP	Meteorological Monitoring Program
mph	miles per hour
MRI	Midwest Research Institute
m/s	meters per second
NBS	National Bureau of Standards
OU	Operable Unit
PT	plot
Pu	plutonium
QA	Quality Assurance

QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
QC	quality control
RAAMP	Radioactive Ambient Air Monitoring Program
RF	Rocky Flats
RFI	RCRA facility investigation
RFP	Rocky Flats Plant
RI	remedial investigation
TOC	total organic carbon
U	uranium

Section 1
INTRODUCTION

1.0 INTRODUCTION

This technical memorandum presents modifications to the RFI/RI Final Work Plan for OU 3 of February 28, 1992. Its purpose is twofold:

1. Incorporate the details of the air sampling program that were not included in the Work Plan as required by the United States Environmental Protection Agency (EPA) and Colorado Department of Health (CDH)

2. Document modifications to the field sampling program that occurred during field work.

The technical memorandum is organized as follows:

- Section 2.0, Changes to the Field Sampling Plan–presents modifications to Section 6.0 of the OU 3 Work Plan including soil, sediment, and groundwater sampling

- Section 3.0, Wind Tunnel Study at OU 3–presents the details of the wind tunnel study that were not included in Subsection 6.3.6.1 of the OU 3 Work Plan

- Section 4.0, Air and Meteorological Plan–presents the details of the air and meteorological monitoring program that were not included in Subsection 6.3.2.2 of the OU 3 Work Plan

- Section 5.0, Changes to the Environmental Evaluation Work Plan and Field Sampling Plan for OU 3–presents the modifications to Section 8.0 of the OU 3 Work Plan

- Section 6.0, References

Section 2

CHANGES TO THE FIELD SAMPLING PLAN FOR SOIL, SEDIMENT, AND GROUNDWATER AT OU 3

2.0 CHANGES TO THE FIELD SAMPLING PLAN FOR SOIL, SEDIMENT, AND GROUNDWATER AT OU 3

This section describes the modifications to Section 6.0, Field Sampling Plan for the OU 3 Work Plan. These modifications were verbally communicated to EPA and CDH during field work activities and also at OU 3 status meetings held on February 11, 1993, and July 16, 1993.

2.1 SOIL

Two soil sampling activities outlined in the RFI/RI Final Work Plan in Subsections 6.3.2.1 and 6.3.2.2 have been modified. Their modifications are presented in Subsections 2.1.1 and 2.1.2 below.

2.1.1 Soil Profile Sampling

The third paragraph in Subsection 6.3.2.1 of the OU 3 Work Plan discusses the method of stair-stepping one wall of the trench with depth during the sample collection process. This method of trenching was superseded by the method outlined in SOP GT.07, and it eliminates the stair-stepping of the trench wall. This current trenching method is a more efficient, less time-consuming method that will achieve the same results. The new trenching method has been substituted for the preliminary method described in the OU 3 Work Plan and has been employed at all RFP OUs to remain consistent with profile sampling techniques.

An additional sampling procedure, not previously outlined in the Final Work Plan was also conducted for each trench. This sampling procedure involved collecting grab samples for each distinct soil horizon encountered in the soil profile trench and then compositing the samples into one sample for each horizon at each trench. The composite samples were analyzed for general soil parameters including clay minerals, specific surface area, bulk density, and radionuclide content.

Several sample locations were moved in the field because of property access problems. Figure 2-1 presents the final soil trench locations.

2.1.2 Surface Soil Survey

Some changes in the number, shape, and location of the surface soil sampling locations have been made since the commencement of the surface soil sampling activities. The general changes to each plot are summarized in Table 2-1 and illustrated on Figure 2-2. Also included on Table 2-1 is the status of the sample plot (completed versus planned) as of March 4, 1993.

Approximately 60 soil sampling locations were identified in the Final Work Plan both within and outside a specified soil grid (refer to Figure 2-1 of the OU 3 Work Plan). Approximately 50 locations were inside the grid and 10 of the locations were outside. Of the 60 locations described, 39 were moved and 21 were left in their original location. Of the 60 locations, a total of 52 locations have been sampled as of April 9, 1993.

Changes in location and shape of each plot were made based on site access and site geometry. The plot locations were initially identified on aerial photographs. Sufficient detail did not exist at all locations to ensure the 10-acre square plot would fit existing land uses and boundaries.

At locations where site access could not be obtained, the plot was relocated. The new location was as close to the original location as possible. In areas with increased development activities, adjacent 10-acre sampling plots were not feasible, so locations were shifted to sites closer to the RFP or to areas with minimal soil disturbance.

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This document (or documents) is oversized for 16mm microfilming, but is available in its entirety on the 35mm fiche card referenced below:

Document # 000148

Titled: figure 2-1, Soil trench locations operable unit 3, Rocky flats, Plants

Fiche location: A-OU03-M1

Table 2-1
SUMMARY OF SURFACE SOIL SAMPLING CHANGES

Surface Soil Sampling Location	Change Made	Sampling Status
PT-125-92	No Change	Planned
PT-126-92	No Change	Planned
PT-127-92	No Change	Completed
PT-128-92	No Change	Completed
PT-129-92	No Change	Completed
PT-130-92	No Change	Planned
PT-131-92	No Change	Completed
PT-132-92	No Change	Completed
PT-133-92	Location	Completed
PT-134-92	No Change	Completed
PT-135-92	Location	Completed
PT-136-92	Deleted	
PT-137-92	Location	Completed
PT-138-92	No Change	Planned
PT-139-92	Deleted	
PT-140-92	No Change	Completed
PT-141-92	No Change	Completed
PT-142-92	No Change	Completed
PT-143-92	Location	Completed
PT-144-92	No Change	Completed
PT-145-92	Location	Planned
PT-146-92	Location	Planned
PT-147-92	Location	Completed
PT-148-92	Location	Completed
PT-149-92	Location	Completed
PT-150-92	Location	Completed
PT-151-92	Location	Completed
PT-152-92	Location	Completed
PT-153-92	Location	Completed
PT-154-92	Location	Completed
PT-155-92	Location	Completed

Field adjustments to the sites were made as necessary when laying out the parcel for sampling. These adjustments were based on each area's general condition. An attempt was made to locate plots in undisturbed areas and areas with similar land use. Following these criteria, parcel locations and shapes were field adjusted to provide the most representative sampling locations.

The second to last paragraph of Subsection 6.3.2.2, Surface Soil Survey of the OU 3 Work Plan, states that samples will be collected using the CDH method only. It was decided to collect an additional sample using the Rocky Flats (RF) method from each soil plot. The RF method samples are composited from 10 samples collected from two 1-meter plots spaced 1 meter apart. The RF sampling location is suitably placed (as described in EMD SOP GT.08) within the 10-acre grid plot.

Both the CDH and RFP sampling methods have historical precedence and therefore both results will be used to compare against historical data. The significance of the difference in sampling methods is unknown at this time, but a comparison between the methods will be made.

2.2 SEDIMENT

One modification to the sediment sampling program was identified. Sediment samples were analyzed for "specific gravity" rather than "bulk density" (modified from Subsection 6.3.3.2.2 of the work plan). Bulk density is a measurement for soils and is not an appropriate measurement of sediments.

Sediment locations were adjusted based on field conditions. Figure 2-3 presents the final field locations for the sediment sampling for OU 3.

2.3 GROUNDWATER

The data quality objective (DQO) for the groundwater wells outlined in the Work Plan was discussed at a meeting with the EPA, CDH, United States Department of Energy (DOE), and EG&G in July

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Titled: Figure 2-3 Sediment Sampling Locations Operable Unit 3, Rocky Flats Plant

Fiche location: A-OU03-M1

1992. All parties agreed that the approach described in the Work Plan would not provide the information needed for the RFI/RI.

The groundwater sampling approach has been modified to drill one well at Standley Lake and one well at Great Western Reservoir. A 45-foot well was located downstream of Standley Lake and one 40-foot well has been located downstream of Great Western Reservoir. These two wells were located as close as possible to each dam. The groundwater intercepted by the well downstream of Standley Lake apparently originates from Standley Lake, since the well is under positive pressure (flowing). The groundwater intercepted by the well placed downstream of Great Western Reservoir is also likely considered to originate from Great Western Reservoir. The wells will assist in the evaluation of the presence of contaminant migration from surface water bodies to shallow (bedrock) groundwater systems.

Additionally, a verbal agreement was reached during a meeting in July 1992 between the DOE, EG&G, EPA, and CDH, stating that drill cuttings generated during the installation of the monitoring wells need not be containerized and were, therefore, disposed of at the drilling location. This TM formally documents the verbal agreement.

2.4 FIELD QC PROCEDURES

This subsection presents modifications to Subsection 6.6, Field QC Procedures, described in the Work Plan. Performance evaluation samples were not collected during the OU 3 field program. Performance evaluation standards are not required by the EG&G sitewide project plan (QAPP), (EG&G, 1991).

Section 3
WIND TUNNEL STUDY AT OU 3

3.0 WIND TUNNEL STUDY AT OU 3

There are two components of the air program at OU 3: the wind tunnel study and the air sampling program (Section 4.0). The purpose of the air program is to characterize the health impact from dispersion of potentially radioactive sediments and soils. Measuring the wind erosion on the shoreline of the reservoirs and on vegetated terrain is difficult; therefore, a combination of air sampling and a special wind tunnel study has been selected as the method of characterization. The air pathway has been identified as one of the primary pathways of concern. To evaluate the pathway, both the wind tunnel study and air sampling will be performed. The primary objective of the air sampling is to obtain additional information on plutonium, americium, and uranium. The RAAMP data will be used in conjunction with the air data. The primary objective of the wind tunnel study is to collect site-specific resuspension potential. This information will be evaluated in the human health risk assessment and will be compared to the default values presented in the Risk Assessment Guidance for Superfund (RAGS) Part B (EPA, 1991).

A three-step process will be applied to assess the health impacts of wind-resuspended radionuclides on public health (Figure 3-1):

1. Characterize the resuspension of soils and sediments using a portable wind tunnel

2. Characterize the transport of the wind-resuspended radionuclides to members of the public using the existing Radioactive Ambient Air Monitoring Program (RAAMP) samplers and ultra high-volume air samplers

3. Calculate the impacts of the wind-resuspended radionuclides on public health using computer-based atmospheric dispersion and radiation dosimetry models

This evaluation will be performed as part of the RA. These objectives will be accomplished by siting a portable wind tunnel sampling system at representative locations within OU 3, simulating a range of wind events characteristic of the region, and quantitatively sampling the resuspended particulates from the surface. Where possible, wind suspension emission rates (g/[sec • m^2]) will be determined for a variety of environmental and source conditions.

The data produced in the study will be used to evaluate relationships between wind erosion emission rate and observable influences, such as:

- Geographical area
- Land use
- Surface cover
- Surface roughness
- Soil type
- Amount of soil disturbance
- Wind speed
- Particle size distribution
- Wind erosion depletion and decay

The portable wind tunnel approach to characterizing wind resuspension is both effort- and resource-intensive. Each test involves the placement, assembly, and preparation of a complex sampling train. A single comprehensive test series may involve the preparation, exposure, and analysis of more than 30 individual filter/substrate media samples.

Several visits to the site by the wind tunnel study subcontractor have revealed that the expected resuspension potential for OU 3 is very low. It is possible that all sampling will be below the detection limit of the wind tunnel. Details of the wind tunnel study including assumptions can be found in Appendix A of this technical memorandum.

A four-step approach has been developed for wind tunnel sampling in OU 3 that will help achieve the project objectives. The four sequential steps are listed below and shown graphically in Figure 3-2. A detailed discussion of these steps is found in Subsections 3.2 and 3.3.

1. Identify and characterize study area with regards to the wind tunnel study
2. Plan and conduct screening tests
3. Plan and conduct comprehensive tests
4. Compile and report data for use in transport modeling

Step 1 has been conducted to characterize the offsite regions which contain the highest historical area of radionuclide contamination. This allows the wind tunnel testing to focus on the area with the greatest potential for health impacts.

The existing knowledge of resuspension potential in OU 3 is not sufficient to identify the exact number and locations of sampling sites needed to characterize emissions from the area. In Step 2, a series of lower-effort screening tests will be conducted with the portable wind tunnel to gather the data needed to plan a series of comprehensive tests.

In Step 3, a program of comprehensive tests will be executed. These tests will produce the range of data needed to meet the objectives as described above.

In Step 4, the data produced in the wind tunnel tests will be analyzed and compiled in a form suitable for atmospheric dispersion modeling.

3.1.1 Identify and Characterize the Study Area (Step 1)

OU 3, by definition, includes all areas beyond the Rocky Flats Plant boundaries that contain above-background levels of radionuclides. However, the highest levels of radionuclide contamination is in

These objectives will identify areas with negligible resuspension rates. These rates will then be quantified at a greater sensitivity and lower level of effort than could be achieved with comprehensive tests.

3.1.3 Plan and Conduct Comprehensive Tests (Step 3)

As previously discussed, the purpose of the comprehensive tests is to produce resuspension data which specifically support a definitive evaluation of long-term public health impacts. The specific objectives of the comprehensive tests are to:

- Provide detailed resuspension information at a sufficient number of sites to characterize both sediments and soils
- Focus on sampling sites where site-specific resuspension can be achieved using the portable wind tunnel
- Establish the wind speed threshold for resuspension in the Resuspension Study Area, and address the geographical variation of the wind speed threshold
- Provide sufficient data to establish a multi-point particle size distribution for resuspension in the Resuspension Study Area, and address the geographical variation of particle size distribution
- Provide sufficient data to evaluate the relationship between wind speed and resuspension emission rate for the Resuspension Study Area, and to address the geographical variation of the relationship
- Provide sufficient data to evaluate the time rate of decay of resuspension emission rate for the Resuspension Study Area, and to address the geographical variation of

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Document # 000148

Titled: U.S. Department of Energy Rocky flats Plant figure 3.3

Fiche location: A-OU03-M1

- Provide sufficient data to evaluate the time rate of decay of resuspension emission rate for the Resuspension Study Area, and to address the geographical variation of the time rate of decay

The total number of comprehensive test sites will vary from 0 (if no resuspension could be produced with the wind tunnel in any of the screening tests) to 14 (if wind erosion and high geographical variability were exhibited during screening tests in all sub-areas).

Each comprehensive test site will be adjacent to a screening test site, and will occupy an area protected from disturbance during the previous tests.

One battery of comprehensive tests will be conducted at each comprehensive sampling site. A complete gravimetric analysis of the filters/substrates exposed during the comprehensive tests, an evaluation of the supporting data gathered, and an estimate of the particulate resuspension emission rates for the tests will be performed. The data will be compiled and reported for use in evaluating the relationships described above.

3.1.4 Compile and Report Results for use in Transport Modeling (Step 4)

Using the detailed results of the screening and comprehensive wind tunnel tests, a quantitative evaluation of the relationships between wind-generated resuspension and the following variables will be completed:

- Surface cover
- Surface roughness
- Soil type
- Amount of soil disturbance
- Wind speed

- Particle size distribution
- Wind erosion depletion and decay

These results will be prepared in a form which can be directly used in the follow-on atmospheric dispersion modeling activities.

3.2 SCREENING TEST PROCEDURE

As with any investigation involving measurements, the portable wind tunnel approach is limited by its ability to accurately measure quantities such as wind speed, flow rate, and filter mass. It is important to understand the limitations of the approach, so that the results of the study can be properly applied in the health effects evaluation. The characteristics used to quantify these limitations are the minimum detectable particulate mass and precision. The objective of the wind tunnel study is to obtain site-specific information to determine particulate resuspension potential. The data obtained from the wind tunnel study will be compared to the default values presented in RAGS (EPA, 1991).

The minimum detectable particulate mass and precision for the screening tests has been specifically calculated and configured with the wind tunnel for the screening tests.

Given the minimum detectable particulate mass, an estimate will be made to identify the minimum public dose that can be evaluated with the portable wind tunnel method. These calculations can be found in Appendix A, Details of the Wind Tunnel Study. The precision of the wind tunnel approach will be combined with that of other steps in the overall process to establish confidence intervals for the final dose and Human Health Risk Assessment from the OU 3 investigation.

3.2.1 Select Screening Test Sites

The Resuspension Study Area has been divided into two sub-areas for investigation during the screening tests:

- Terrestrial areas

- Exposed shoreline sediments at Standley Lake Reservoir and Great Western Reservoir

3.2.1.1 Terrestrial Areas

A set of site selection criteria has been developed for the Terrestrial Areas, intended to ensure that test locations support the screening test objectives. Under these criteria, sampling sites must characterize:

- The Settlement Agreement Property
- Previous soil sampling locations
- Sites of potentially higher resuspension

3.2.1.2 Exposed Shores and Sediments at Standley Lake Reservoir and Great Western Reservoir

A set of site selection criteria was also developed specifically for the exposed shores and sediments around Standley Lake Reservoir and Great Western Reservoir. Under these criteria, sampling sites will characterize:

- The circumference of shoreline around Standley Lake Reservoir

- The circumference of shoreline around Great Western Reservoir

- The inlet of Woman Creek to Standley Lake Reservoir (a historical source of water-borne contamination from the Rocky Flats Plant)

- The inlet of Walnut Creek to Great Western Reservoir (a historical source of water-borne contamination from the Rocky Flats Plant)

- A recreation area where exposed shores receive heavy public use

3.2.2 Microscale Site Selection

Additional criteria for microscale screening site selection have also been developed. The criteria are intended to allow the portable wind tunnel to be transported, assembled, and operated effectively. Under these criteria, each site must have:

- A sufficiently flat area so that the wind tunnel sampling train can be properly deployed and independent disturbed and undisturbed tests can be conducted (area approximately 20 ft x 50 ft)

- Vegetation no more that 1/2 the height of the working section of the wind tunnel (approximately 6 inches)

- Adequate access for transporting the wind tunnel and supplementary equipment

- Existing soil sampling sites nearby if possible

Based on these criteria, four sample sites were selected in the terrestrial areas and six sample sites were selected at the exposed shores and sediments at Standley Lake and Great Western Reservoir. The sites are described in Table 3-1.

3.2.3 Screening Test Process

Figure 3-4 presents the process flow for the screening tests. As shown, top-down planning and careful site selection are essential components of the approach.

Two screening tests will be conducted at each sampling site. One test will quantify the maximum resuspension rate from an undisturbed surface. A second test will examine the resuspension rate when an adjacent surface is cleared of vegetation and thoroughly disturbed. This will allow bracketing of land use influences at each site–from maximum natural protection to maximum disturbance.

Gravimetric analysis will be completed on the filters exposed during the screening tests, supporting data will be evaluated, and resuspension emission rates for the tests will be produced. The data will be evaluated to determine the number and distribution of comprehensive tests needed.

3.2.4 Screening Test Methodology

Each screening test will:

- Include a subthreshold velocity profile to establish surface roughness parameters
- Include an ambient particulate monitor to establish background particulate levels in the flow approaching the wind tunnel inlet
- Utilize a cyclone preseparator to minimize particle bounce

Table 3-1
WIND TUNNEL TESTING STRATEGY

		State Plane Coordinates				Terrestrial Areas		
Site ID	Corresponding Soil Sample Location	Northing	Easting	Corner	Particulate Type	Land Use	Location	Purpose
T-1	PT14192	749832.2163	2094864.9803	SW	Soil	Remediation Land	On remediation land southwest of Great Western Reservoir	Characterize the most contaminated area (historically of greatest concern)
		750492.2163	2094864.9803	NW				
		750492.2163	2095524.9803	NE				
		749832.2163	2095524.9803	SE				
T-2	PT14292	746012.2555	2094791.8926	SW	Soil	Remediation Land	On remediation land south of Great Western Reservoir	Characterize the most contaminated area (historically of greatest concern)
		746672.2555	2094791.8926	NW				
		746672.2555	2095451.8926	NE				
		746012.2555	2095451.8926	SE				
T-3	PT15192	749376.9101	2098076.4116	SW	Soil	Grazed Plowed Land	Between the remediation land and Standley Lake	Characterize areas downwind of the remediation land
		750036.9101	2098076.4116	NW				
		750036.9101	2098736.4116	NE				
		749376.9101	2098736.4116	SE				
T-4	PT15492	737332.6457	2101226.8543	SW	Soil	Overgrazed Pasture	Peninsula at southwest of Standley Lake	Characterize the least vegetated portion of the Resuspension Study Area with the most suspendible soil surface
		737992.6457	2101226.8543	NW				
		737992.6457	2101886.8543	NE				
		737332.6457	2101886.8543	SE				

Table 3-1
WIND TUNNEL TESTING STRATEGY
(Continued)

Exposed Shores and Sediments at Standley Lake Reservoir and Great Western Reservoir

		State Plane Coordinates				Reservoir Shoreline Areas		
Site ID	Corresponding Sediment Sample Location	Northing	Easting	Corner	Particulate Type	Land Use	Location	Purpose
S-1	SED 03992	741869.8370	2100812.1360	SW NW NE SE	Sediment	Light recreation	Near the inlet of Woman Creek to Standley Lake	Characterize the western shores of the lake and sediments transported by Woman Creek
S-2	SED 04792	736216.0140	2107217.1530	SW NW NE SE	Sediment	Light recreation	Southeast shore of Standley Lake near the concreted inlet of a small stream	Characterize the south and southeast shores of Standley Lake
S-3	SED 03692	743403.0640	2105663.4340	SW NW NE SE	Sediment	Heavy recreation	Northeast shore of Standley Lake	Characterize the north and northeast shores of Standley Lake and the exposed beach most heavily used for fishing recreation

Table 3-1
WIND TUNNEL TESTING STRATEGY
(Concluded)

Exposed Shores and Sediments at Standley Lake Reservoir and Great Western Reservoir (continued)

Site ID	Corresponding Sediment Sample Location	State Plane Coordinates: Northing	State Plane Coordinates: Easting	Corner	Particulate Type	Reservoir Shoreline Areas: Land Use	Reservoir Shoreline Areas: Location	Reservoir Shoreline Areas: Purpose
S-4	SED 002	746232.8446	2093953.8860	SW NW NE SE	Sediment	None	Near the inlet of Walnut Creek to Great Western Reservoir	Characterize the western shores of Great Western Reservoir and sediments transported by Walnut Creek
S-5	SED 06892 S-5	750442.7770	2098154.9690	SW NW NE SE	Sediment	None	Southeast shore of Great Western Reservoir	Characterize the south and southeast shores of the Great Western Reservoir
S-6	SED 05792 S-6	752728.4040	2098126.0660	SW NW NE SE	Sediment	None	Northeast shore of Great Western Reservoir	Characterize the north and northeast shores of the Great Western Reservoir

TBD = To be determined.

DRAWN BY	Douville 04/02/93	CHECKED BY	APPROVED BY	4/23/93	4/23/93	DRAWING NUMBER	RF1097

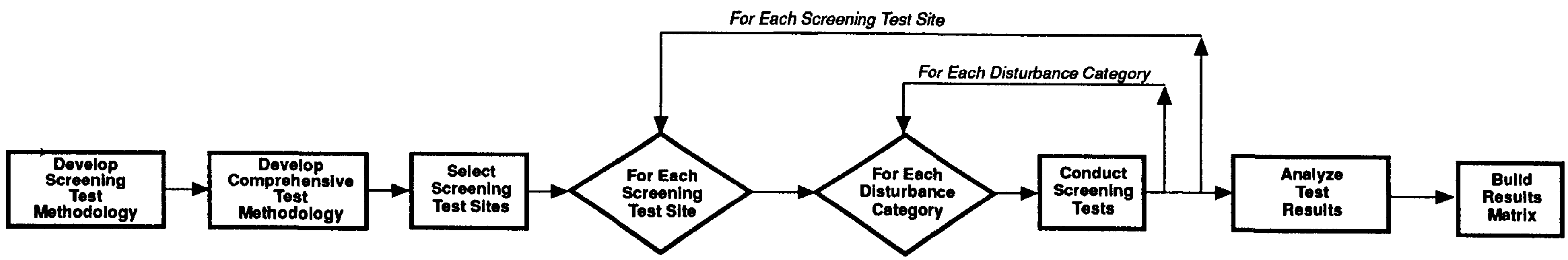

Figure 3-4
PROCESS FOR PLANNING AND CONDUCTING SCREENING TESTS OF RESUSPENSION POTENTIAL USING THE PORTABLE WIND TUNNEL AT OPERABLE UNIT 3, ROCKY FLATS PLANT

- Produce a 10 micrometer (μm) aerodynamic diameter cut point

- Capture and gravimetrically analyze all particle sizes of resuspended dust (in two size categories—below 10 μm and 10 μm and above)

Two screening tests will be conducted at each sampling site—one on an undisturbed surface and one on a thoroughly disturbed surface. The tests will be planned so that minimal movement or adjustment of equipment is necessary. For instance, the undisturbed and disturbed sites may be established on closely adjacent arcs so that the blower unit can be rotated rather than moved.

An undisturbed test will evaluate wind erosion from a ground surface in its natural state. No footprints, equipment tracks, or other impacts of any sort will be allowed on the surface to be tested.

A disturbed test will evaluate wind erosion from a ground surface in a "thoroughly disturbed" state. No published standard or procedure for disturbing ground surfaces for resuspension testing has been identified. Therefore, an objective method has been designed specifically for this study. All vegetation will be clipped at ground level and removed. Each set of vegetation will be bagged and labeled for potential future analysis. Then, the soil, rocks, and ground cover will be thoroughly loosened by raking or other mechanical means. This approach provides the risk manager with data concerning future development (construction activity) disturbance. Disturbed areas will be reseeded and covered with a mulch to control future resuspension.

3.2.5 Screening Test Results Matrix

Figure 3-5 shows the test results matrix. Three outcomes are possible for each sampling category:

- No detectable resuspension occurred (and thus no comprehensive tests are needed for the given disturbance category and sub-area)

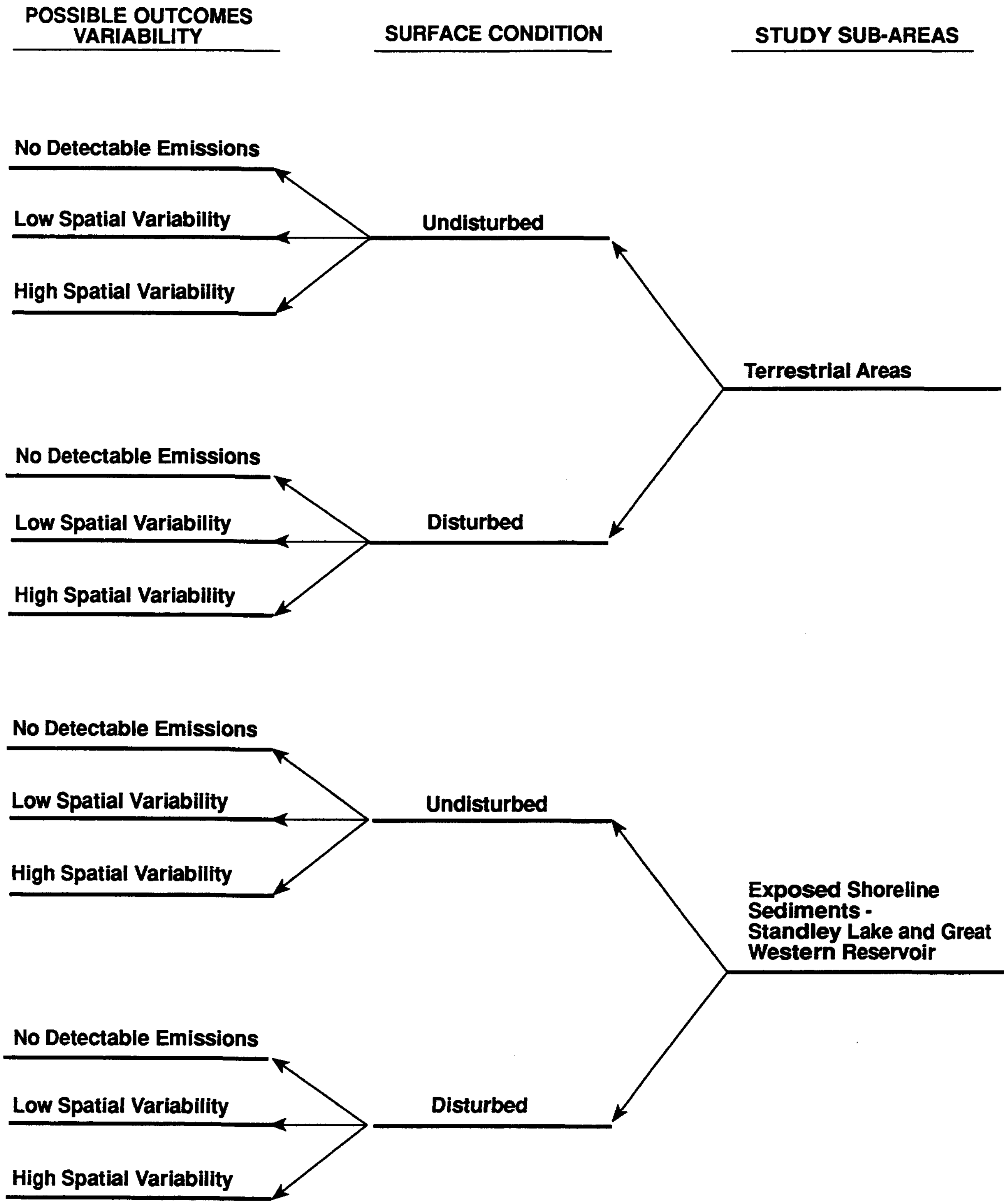

Figure 3-5
TEST RESULTS MATRIX FOR SCREENING TESTS

DRAWN BY	CHECKED BY		APPROVED BY		DRAWING NUMBER
Douville 04/02/93		4/23/93		4/23/93	RF1098

- Spatial variability was below the method precision (Subsection A.3.5.2) so that a single comprehensive sampling site can represent the given disturbance category and sub-area

- Spatial variability was above the method precision (Subsection A.3.5.2) so that multiple comprehensive sampling sites will be needed to represent the given disturbance category and sub-area

An examination of the matrix indicates that the 12 decision branches can combine to produce 81 possible sampling designs for the comprehensive tests. Examples of sampling designs include the following:

- No comprehensive testing at all (no resuspension could be detected at maximum wind tunnel flow rates at any location)

- A single sampling location in each sub-area

- Multiple sampling sites in a sub-area of high variability

- Multiple sampling sites in all sub areas

3.2.6 Screening Test Deliverables

The final deliverables of the screening tests will be:

- Surface roughness and wind speed profile characteristics for each screening sampling site and surface type

- Site-by-site maximum particulate resuspension rates and supporting data for undisturbed surfaces

- Site-by-site maximum particulate resuspension rates and supporting data for disturbed surfaces

- A Results Matrix, detailing the geographical sampling pattern needed during the comprehensive tests

3.3 COMPREHENSIVE TEST PROCEDURE

Once the screening test results have been examined, a decision will be made regarding the exact types and locations of comprehensive tests to be completed. Input will be sought from the subcontractor, qualified contractor personnel, EPA, DOE, and CDH.

The comprehensive wind tunnel tests will expose many more filters/substrates than the screening tests, primarily in order to resolve the particle size distribution in the resuspended particulates. Thus, more gravimetric analyses and other measurements will be performed for the comprehensive tests. In addition, the total mass captured in a wind tunnel test will be distributed over more filters than in the screening tests–a smaller mass of particulates will be captured on each filter. As a result of these changes, the precision of the comprehensive tests will be lower than that of the screening tests. The overall minimum detectable particulate emission rate for the comprehensive tests will be higher than that of the screening tests.

3.3.1 Comprehensive Test Methodology

Each battery of comprehensive tests will cover the following:

- A sub-threshold velocity profile to establish surface roughness parameters
- An ambient particulate monitor to establish background particulate levels in the flow approaching the wind tunnel inlet
- Utilization of a cyclone preseparator to minimize particle bounce
- A catch and gravimetric analysis of all resuspended dust, regardless of particle size (requiring analysis of the cyclone catch)
- A multi-point particle size distribution analysis of resuspended dust (requiring multi-stage impactor with greased substrates), including one cut point at 10 μm aerodynamic diameter
- A two-point wind speed characterization (one at the median of the wind erosion threshold and the wind tunnel maximum speed, and one at wind tunnel maximum speed)
- A two-point wind erosion decay characterization

A given battery of comprehensive tests may be conducted on either a disturbed or undisturbed surface. The definition of each surface type is discussed in Subsection 3.2.4, "Screening Test Methodology."

3.3.2 Analyze Comprehensive and Supplemental Test Results

The filter media will be gravimetrically analyzed in each comprehensive and supplemental test. The data analysis approach is described in Appendix A. Wind profile parameters and resuspension rates [g / (sec • m^2)] will be calculated for each test.

3.3.3 Comprehensive Test Deliverables

The final deliverables of the comprehensive tests will be:

- Surface roughness and wind speed profile characteristics for each comprehensive sampling site and surface type

- Particulate resuspension rates and supporting data for each comprehensive test conducted as defined in the final comprehensive testing plan

3.3.4 Conduct Supplemental Tests as Appropriate

Supplemental wind tunnel tests may be conducted if additional project resources are available beyond those needed for the comprehensive tests. Supplemental tests may include:

- Tests at additional wind speeds to better define the shape of the wind speed relationship

- Additional tests in sequence at a single site to better define the shape of the wind erosion decay rate

3.4 QUALITY ASSURANCE

The quality assurance (QA) for the sampling media include a quantitative review of the accuracy and precision of the measurement systems and the qualitative evaluation of the completeness and representativeness of the data. Table 3-2 gives the QA and procedures for the sampling media, both pre- and post-test. The goal for this study is ≥90 percent completeness for all sampling media.

As indicated in Table 3-1, 5 percent laboratory blanks and 5 percent field blanks will be collected for QC purposes (EPA, 1977). This involves handling of 1 filter in every 10 in an identical manner as the others to determine systematic weight changes. These changes are then used to mathematically correct the net weight gain determined from gravimetric analysis of the filter samples. In the case of laboratory blanks, this involves only those procedures followed in the Subcontractor's gravimetric weigh room. For field blank collection, a filter is actually loaded into a sampler and then immediately recovered without air actually being passed through the media.

DQOs for sampler flow rates are as follows:

- BGI orifice criterion–per MRI SOP EET-620 (Appendix B of this document).
- Hi-Vol calibration criterion–target flow rate using the BGI orifice as the secondary flow standard.

Table 3-2
QA FOR SAMPLING MEDIA

Activity	Cond. Time	QA Requirements Pre-test	QA Requirements Post-test
Room conditions for weighing		Temperature = 23°C ± 1°C Relative Humidity = 45 percent ± 5 percent	
Daily calibration		Calibrate balance prior to and after use, and every 4 hours during use. Precision = ± 0.5 mg of actual weight	
First weighing minimum weight	24 hours	100 percent of filters	100 percent of filters 3 X background[1]
Second weighing accuracy limit	24 hours	100 percent of filters ±1.0 mg	10 percent of filters ±2.0 mg
Field blanks		≥10 percent of total filters used	
Laboratory blanks		≥5 percent of the total filters used	
Completeness		≥90 percent	≥90 percent

[1]Background is defined as the mean value of the field blank samples

Note: See SOP EET-610.

Section 4
AIR AND METEOROLOGICAL MONITORING PLAN

4.0 AIR AND METEOROLOGICAL MONITORING PLAN

4.1 CHARACTERIZATION OF TRANSPORT OF WIND-RESUSPENDED RADIONUCLIDES FOR THE AIR MONITORING PROGRAM

A two-tier approach will be used to characterize the transport of wind-resuspended radionuclides from OU 3. First, selected existing RAAMP samplers will be used to measure the transport of radionuclides around OU 3. Second, three ultra high-volume air samplers will be installed to further clarify the data from the RAAMP network. All data taken will adhere to approved QA and QC procedures.

4.1.1 Existing RAAMP Samplers

Radioactive ambient air samplers monitor airborne dispersion of radioactive materials from RFP into the surrounding environment. Samplers are designated in three categories by their proximity to the main facilities area. Twenty-five onsite samplers are located within RFP, concentrated near the main facilities area. Fourteen perimeter samplers border RFP along major highways on the north (Highway 128), east (Indiana Street), south (Highway 72), and west (Highway 93). Fourteen community samplers are located in metropolitan areas adjacent to RFP. Samplers operate continuously at a volumetric flow rate of approximately 12 liters per second (l/s) (25 cubic feet per minute [cfm]), collecting air particulates on 20 x 25-centimeter (cm) (8 x 10-in) fiberglass filters. Manufacturers test specifications rate this filter media to be 99.97 percent efficient for relevant particle sizes under conditions typically encountered in routine ambient air sampling.

Filters are collected biweekly from all RFP samplers. Each filter is collected biweekly, composited by location, and analyzed monthly for plutonium.

Data from several of the RAAMP samplers around OU 3 will be examined for evidence of transport of wind resuspended radionuclides from OU 3. The analytical lab data will be correlated with meteorological data from the same period to determine transport from OU 3.

4.1.2 Ultra High-Volume Air Samplers

Three ultra high-volume samplers will be located in OU 3 to further characterize the transport of wind-resuspended radionuclides. The first sampler will be located on 100th Avenue, approximately 0.2 miles east of Alkire Street. This location was chosen due to its proximity to the Settlement Agreement Area. The second sampler will be located approximately 0.4 miles east of the end of west 88th Avenue, east of Alkire Street. The sampler will be located near the shore of Standley Lake Reservoir to represent a recreational receptor. The third sampler will be located at the corner of west 88th Avenue and Kipling Street, adjacent to the water gauging station. This sampler location was chosen to represent local residential receptors.

The ultra high-volume samplers will be running at an air flow of approximately 600 cfm and use a special filter as a collection media. The higher flow rate will produce a much larger sample to analyze, which should decrease the detection limits.

It is expected that the ultra hi-vol samplers will be changed biweekly, but the exact schedule for changes will ultimately be determined by filter loading.

4.2 METEOROLOGICAL DATA SOURCES

The meteorological data for use in calculations will be obtained from two sources. The first is the existing meteorological data collected at RFP and the second will be two meteorological stations to be constructed in OU 3.

The existing Meteorological Monitoring Program (MMP) at RFP has been designed on the basis of the types of activities at the site, topographical characteristics, and the distance to the critical receptors of possible airborne emissions. The 61-meter tower, located west of the main facilities area, stands on a flat, grassy mesa defined by the Rock Creek drainage area to the north and the Woman Creek drainage to the south.

The existing instrumented 61-meter tower located on the west side of the plant, and a redundant, instrumented, 10-meter tower approximately 100 meters northeast of the primary tower. These towers are located in an area that is representative of the atmospheric conditions into which material from the plant could potentially be released and transported.

The 61-meter tower has instrumentation placed at three different heights: 10, 25, and 60 meters, respectively. At each level, the following measurements are taken at the tower:

- Horizontal wind speed and direction
- Vertical wind speed
- Ambient air temperature
- Dew point temperature at 10 meters
- Solar radiation at 1.5 meters above ground surface
- Precipitation and atmospheric pressure at ground surface

The 10-meter tower is located approximately 100 meters northeast of the 61-meter tower. This tower's backup data/redundancy function covers the following measurements:

- Horizontal wind speed and direction
- Vertical wind speed
- Ambient air temperature and relative humidity
- Precipitation

The second source of meteorological data will be two stations to be constructed in OU 3. The first is a 10-meter tower, and the second is a 2-meter tower. The 10-meter tower will be located on the Jefferson County Open Space directly east of the plant. This station will take wind speed, wind direction, temperature, relative humidity and vertical wind speed every 0.5 seconds, and compute a 15-minute average continuously. The second meteorological station will be collocated with the ultra hi-vol at 88th and Kipling, and be approximately 2 meters high. The data from this station will be correlated directly with the sampler, to give receptor specific data. Wind speed and wind direction will be taken every 0.5 seconds and averaged over a 15-minute interval.

4.3 CALCULATE THE IMPACTS OF WIND-RESUSPENDED RADIONUCLIDES ON PUBLIC HEALTH

Finally, the data from the wind tunnel study, as well as the RAAMP program and the ultra high-volume samplers will all be combined and used with atmospheric dispersion and radiation dosimetry models. These models will be used to estimate risks at location that are distant from OU 3 in the future use exposure scenarios. Additionally, the models will be used to evaluate the effects of different remediation alternatives as appropriate. The data from the wind tunnel study will be used as input to the model, while the RAAMP and ultra high-volume sampling data will be used to confirm the output of the model.

Section 5
CHANGES TO THE ENVIRONMENTAL EVALUATION WORK PLAN AND FIELD SAMPLING PLAN FOR OU 3

5.0 CHANGES TO THE ENVIRONMENTAL EVALUATION WORK PLAN AND FIELD SAMPLING PLAN FOR OU 3

5.1 INTRODUCTION

RFI/RI field work at OU 3 was not started until late May 1992, as compared to a planned startup in March or early April. As a result, some changes were made to the original Environmental Evaluation (EE) plans in order to start the field investigation as soon as possible. The spring sampling season had already passed, and the EE efforts in June 1992 were directed at implementing field work before more time was lost. Additionally, during late May and June, information from the preliminary analysis of data from Operable Units 1 and 2 (OU 1 and OU 2) became available. These data suggested that an assessment approach emphasizing comparisons of onsite and reference (control) areas at OU 3 would be inappropriate. Concurrently, initial field surveys on OU 3 provided information supporting the fact that an onsite versus reference area approach would not be appropriate for OU 3. In response to the above information, alternate EE approaches were discussed, a rationale was developed for the preferred approach, and appropriate modifications were made to the field sampling plan. The following subsections provide information on the differences between the original Field Sampling Plan (FSP) in the EE Work Plan and the actual sampling activities.

5.2 REFERENCE AREAS

The EE Work Plan in the Final RFI/RI Work Plan for OU 3 presented an ecological risk assessment approach that used reference (or control) sites in offsite areas that would be similar to onsite sampling areas. The objective of this approach is to find onsite and reference areas that are essentially identical, except for the presence of the RFP-related contaminants such as plutonium and americium. In an ecological context, this is frequently difficult to perform because of the multitude of variables, both biotic and abiotic, that influence ecosystems.

As OU 3 field investigations began in June 1992, a preliminary assessment of OU 1 data was provided, indicating that the onsite versus reference area approach was not working as well as expected at OU 1. Since the OU 3 area was bigger, more diverse, more influenced by factors unrelated to RFP, and had lower levels of contaminants than OU 1, it was even less likely that onsite versus reference comparisons would work at OU 3. The initial work on OU 3, including qualitative field surveys and activities under subtasks 1.5, 1.6, and 2.3 also indicated that the use of onsite versus reference comparisons would have limited value for the EE on OU 3. Most areas within OU 3 have been impacted by prior land use decisions, and the ecosystems within OU 3 strongly reflect the earlier or current land uses associated with agriculture, residential development, and water resource management facilities. Finding comparable reference areas with a similar land use history, so that comparisons between the onsite and reference areas would reveal the effect of low levels of contaminants, was determined to be impractical.

Some limited use of reference areas was retained for specific purposes. For example, fish were collected from a small reservoir upgradient from the main RFP complex to obtain tissue samples for assessing natural baseline levels of metals and radionuclides. However, the major emphasis of the OU 3 EE was switched to an approach that would measure a number of abiotic parameters, including the concentrations of potential RFP contaminants, at the same time as the ecological endpoints. This approach, then, would evaluate the influence of the contaminant concentration and other abiotic variables on ecological endpoints, such as species diversity or plant cover, and assess which parameters influenced the endpoints the most.

5.3 AQUATIC ECOSYSTEMS

5.3.1 Seasonal Sampling

The delayed start of the RFI/RI field work was the overriding factor that required a shift from the original plans for seasonal sampling. Tasks 1 and 2 (data and literature review, developing initial risk assessment approach, etc.) were shortened in order to start field work as soon as possible. However, most of June was required for equipment procurements, developing health and safety plans, and preparing final field plans and procedures; therefore, the primary field activities did not begin until early July 1992. Seasonal sampling for fish and benthic invertebrates within the OU 3 reservoirs was retained, with mid-summer and fall seasons. There was a significant change in water temperature and diet factors between these two seasons, so seasonal aquatic sampling within the reservoirs was considered necessary. In the creeks, only low-flow sampling was performed because of the field work delays mentioned above.

5.3.2 Creek Sampling

By the time field work began in July, the creeks within OU 3 were either dry or under low-flow conditions. Natural flows no longer occur in Woman or Walnut Creeks east of Indiana Street. The flows are diverted in both drainages and are further complicated by their interaction with the irrigation system. Walnut Creek no longer flows between Indiana Street and Great Western Reservoir since it was diverted through the diversion ditch around Great Western Reservoir. Woman Creek only exhibits flows during the Spring season from Indiana Street to its junction with Church Ditch, and most of the flow from Woman Creek is diverted to Mower Reservoir for irrigation purposes. Almost all the creeks in the area upstream of Great Western Reservoir and Standley Lake are naturally ephemeral and dry up in the summer. Some creek sections however, have flows supported by discharges from irrigation ditches or the water supply reservoirs within OU 3. Creek sampling for OU 3 during the summer was possible at three of the seven stations identified in the work plan. Sampling at these three stations was conducted only during the summer because the creeks remained under no or low-flow conditions throughout the summer and fall. Seasonal sampling, therefore, was not appropriate. These three creek stations were also used to collect water and sediment samples for toxicity tests (see Subsection 8.3.4 of the Work Plan).

5.3.3 Tissue Analyses

The OU 3 EE Work Plan included collecting benthic macroinvertebrates and fish for tissue analysis, to document the body burdens of metals and radionuclides in these organisms. During field sampling, it became apparent that most benthic macroinvertebrates in the OU 3 area were smaller organisms that would not provide enough tissue mass for analysis. There were some larger benthic organisms in the creeks, but their abundance was low. Since the quantity of tissue was low, and the creek stations were in areas where flows were largely from sources unrelated to RFP, benthic macroinvertebrates were not used for tissue analysis.

The EE Work Plan also called for analyzing specific internal organs from one or two of the more common fish species. Liver and kidney samples were taken from a few species, but the total tissue mass was not adequate for preparing separate samples for each collection location. Liver tissue was composited to obtain one sample from each of the two larger reservoirs within OU 3.

5.3.4 Toxicity Testing

The EE Work Plan identified nine sampling locations for toxicity testing: five creek stations, two stations in Mower Reservoir, and two reference stations. Because most creek stations were dry when OU 3 field work began, the number of sampling stations was reduced. Also, since the creeks remained under low-flow conditions throughout the summer and fall, only one season (summer) was sampled. Three creek stations were used for toxicity sampling (two stations identified in the work plan plus Big Dry Creek just below Standley Lake). These three stations were the only ones that had continuous flows through the summer, and the only creek stations sampled for biota. The three stations were:

- BIO15192–Walnut Creek below Great Western Reservoir
- BIO15292–Woman Creek just above Standley Lake
- BIO15392–Big Dry Creek just below Standley Lake

Three stations on Mower Reservoir were sampled instead of two. Two reference stations were proposed, one at a reservoir and one along a drainage. Only one reference station was sampled because only one suitable reference station was found for the creek habitat (on a southern branch of Woman Creek). No suitable reference location was found for the reservoir. An additional station was added in Mower Reservoir, in a wetland area near the inlet of Mower Ditch which supplies the water for this irrigation reservoir.

The summer toxicity tests for water followed the standard EPA protocol using *Ceriodaphnia* and fathead minnows, as stated in the Work Plan. The Work Plan did not specify which protocol would be used for sediments. Based on discussions with the toxicity laboratory, an ASTM-approved protocol using whole sediment samples and the amphipod *Hyalella* was used. Similar sediment protocols are available using species of *Chironomus* (midge larvae), but these midges are generally more tolerant to metals than the amphipod, *Hyalella*. Because the fate and transport mechanisms for the radionuclides of concern are in many ways similar to fate and transport mechanisms for metals, it was determined that *Hyalella* would be more sensitive, or at least as sensitive, to radionuclides as *Chironomus*.

Other sediment protocols are available using *Ceriodaphnia* and fathead minnows, but these protocols require extracting the interstitial or pore water from sediments. This procedure is labor-intensive, requires large volumes of sediments, and tests only contaminants that are carried within the interstitial water. The protocol with *Hyalella* considers both the interstitial water and contaminants adhering to the sediments.

Both Walnut and Woman Creeks were dry at most locations upstream of the reservoirs in OU 3 when 1992 field sampling began in July. Therefore, it was impossible to conduct the toxicity tests planned during the spring season when these creeks are flowing. However, spring-time toxicity data from Walnut and Woman Creek locations upstream of OU 3 were available from EG&G. These stations are closer to potential contaminant sources than the OU 3 stations, and were used to test for acute toxicity.

In Woman Creek, toxicity samples were collected from within Pond C-2 during Spring 1990, 1991, and 1992, and from the Pond C-2 discharge in Spring 1990. Fathead minnow and *Ceriodaphnia* survival was 100 percent in all these samples, indicating no acute toxicity. In Walnut Creek, toxicity tests were run with water from the Pond A-4 discharge during the Spring of 1990, 1991, and 1992; and with water from Pond B-5 during Spring 1991 and 1992. None of these samples produced a toxic effect, and survival was usually at or near 100 percent.

The Spring sampling by EG&G was usually conducted on a monthly basis, and water was collected from within or just below water retention ponds just downstream of the main RFP facility. Since acute toxicity was not detected at these locations near the main plant, it is likely that OU 3 stations farther downstream (and farther away from contaminant sources) would also not be toxic.

The EE Work Plan stated that both acute and chronic tests would be conducted for OU 3. Based on the fact that most toxicity tests from other Rocky Flats programs have not detected acute effects, only chronic tests were performed during the summer sampling period. It is unlikely that water and sediment samples from offsite locations will exhibit acute toxicity when prior samples from onsite locations have not. Also, laboratory records that are kept during the course of the chronic tests will allow the laboratory to determine if acute effects may be occurring.

5.3.5 Other Changes

There were several minor changes made to the original work plan that resulted primarily when actual field conditions or the absence of certain habitats required some logical modifications. For example, Mower Reservoir was shallower than expected and was adequately sampled for fish by using two rather than three sampling stations. The number of reservoir stations for periphyton sampling was also changed so that three stations were established in each reservoir (Mower, Great Western, and Standley) and the reference locations were dropped. Also, the creek stations that were dry were not sampled for surface water or biological samples.

5.4 TERRESTRIAL ECOSYSTEMS

This section refers to Subsection 8.3.3 of the Work Plan. Section 8.0 of the Work Plan stated that, "as more data from other OUs and the spring collection of data become available, the methods should be reviewed and changes made as appropriate." Subsection 8.3 of the Work Plan states:

> The following FSP is provisional and will be periodically revised as appropriate. This sampling plan is largely complete but may be modified as the EE is implemented...in order to coordinate with the OU 3 RFI/RI site characterization and sampling at other OUs, and to update the FSP as additional information is gained during the EE process (DOE, 1992).

Review of early data from OU 1 and OU 2 revealed the need for the changes described below. The following subsections describe the changes made to the scope of work, the new procedure(s), and the rationale for the changes made to the terrestrial ecological field sampling plan.

5.4.1 Changes in Scope and Field Sampling Methods

Revision No. 1

- **Change**–The quantitative vegetation and small mammal plots were located directly over the proposed soil trenches or RFP soil plots. Plots were used for vegetation productivity (plant material was clipped), cover (estimated to nearest percent), plant tissue collection, and for small mammal trapping and animal tissue collection. Clipped plant material was composited rather than separated by species. Clipped plant material was not oven-dried, but frozen immediately and stored until shipped to laboratory. Configuration of vegetation plots and small mammal trapping grids was tightened to correspond as close as possible to the soil sample locations. Some of these sites were sampled for the more standard point-intercept/belt transects conducted for site characterization, as well as co-located quantitative production/tissue measurements.

- **Procedure**–Vegetation cover plots were located along point-intercept and belt transects of 50 meters. Production plots were located separately from the vegetation cover plots, and were moved to be collocated with soil trenches. Small mammal trapping grids were reduced to a small grid of 25 traps as allowed in the SOP.

- **Rationale**–The field sampling data needed to be relatable in space and time for corresponding biotic and abiotic data in order to interpret stressor-response relationships of contaminant concentrations and distribution of ecological variables or ecological effects. For this reason, the biotic variables were measured in the same locations as the principle source of contaminants (soils). Samples were processed as little as possible so measurements were close to field values.

Revision No. 2

- **Change**–Additional habitat types not included in SOP EE.11 were identified in OU 3, and additional environmental scalers were added for habitat determination to record variables for analysis and interpretation.

- **Procedure**–The additional habitat types that were identified at OU 3 were commercial and residential areas, cropland and abandoned cropland (tame pastures), infrastructural features (such as roads and water management structures), and remediation lands (disked and reclaimed areas). The associated habitat types will be mapped accordingly on final maps produced for the study area. An additional form was produced to record environmental scalers for each terrestrial sample site.

- **Rationale**–The additional habitats not found onsite RFP but found on OU 3 needed to be identified. The addition of the environmental scalers for other biotic and abiotic variables allows better analysis and interpretation for environmental parameters analyzed from the data.

Revision No. 3

- **Change**–The small mammal trapping procedures that were changed were (1) measuring total body and tail length, (2) marking captured animals, and (3) completing trap check within 4 hours of sunrise.

- **Procedure**–The total body and tail length were not measured; captured animals were marked with hair clip rather than a pelage dye; and on some traps line checking was completed up to 11 a.m.

- **Rationale**–These changes were made to make the trapping efforts more efficient with no loss of data. Body and tail length were not measured because length on a living, tense, moving animal is not accurate and is generally used for species identification (which was not needed). Hair clipping is more efficient, reliable, and nonintrusive to the animal in the summer time. Hoods were used over all traps to prevent overheating. The hoods, combined with this summer's mild temperatures, allowed for a greater leeway in the trap line checking period. There were no mortalities.

5.4.2 Sampling Periods and Schedule

These changes were made to accommodate a late start for the seasonal sampling and the increased sampling intensity during the summer. The changes and reasons for the changes are given below:

Revision No. 4

- **Change**–The FSP called for initial qualitative field surveys starting in the spring, coinciding with the start of the growing season, and quantitative biotic sampling in early and late summer. The schedule for terrestrial ecological sampling for vegetation, birds, and small mammals at all sites was changed and surveys and sampling were conducted during the mid-summer season from late June through mid-August. The early season (April to late May) qualitative and quantitative sampling as well as the late season sampling was not conducted. No quantitative surveys or plant tissue sampling for wetland plants was conducted.

- **Rationale**–The early season qualitative and quantitative sampling was delayed because of delays with the soil trenching activities. The late season sampling was not conducted because the biotic variables did not change from the sampling conducted during the mid-summer season. Therefore, a second sampling of the vegetation and mammals populations was no longer applicable. The biotic variables were sampled before the soil trenches were excavated since the excavation would have destroyed the vegetation. Wetland plants were not sampled for the tissue analysis since early season surveys of drainages indicated that the wetlands are in previously disturbed areas, are heterogenous, and the water to the wetlands is controlled by irrigation and water management canals.

Section 6
REFERENCES

TITLE: References

Approved By:

Name (Date) / /

6.0 REFERENCES

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Appendix A
DETAILS OF THE WIND TUNNEL STUDY

TITLE: Details of the Wind Tunnel Study

Approved By:

Name (Date) / /

APPENDIX A. DETAILS OF THE WIND TUNNEL STUDY

This appendix provides additional detail to the wind tunnel study and includes the following:

- Screening test assumptions
- Risk-based siting methodology and screening of test sites
- Wind tunnel study technical requirements
- Quality assurance procedures

The purpose of the wind tunnel study is to obtain site-specific resuspension potential.

A.1 SCREENING TEST ASSUMPTIONS

The screening tests will focus on areas of historically higher contamination. Several visits by the wind tunnel study subcontractor to the site have estimated that the resuspension potential for OU 3 is very low. From past experience, the wind tunnel tests will be collecting very little mass, if any. Thus, the following assumptions have been made:

- That total mass collected on the filter paper will be 3 milligrams.

- The contamination level of resuspended soil is the same as that measured by soil sampling.

Long-term atmospheric plutonium concentrations of 0.0001 picocuries per cubic meter equate to a risk of 1 in 1 million (1×10^{-6}) deaths from inhalation (assumes inhalation of 20 m^3/day for 30 years and a cancer slope factor of $3.8e^{-8}$ per picocurie). Risks greater than 1×10^{-6} are considered to be significant risk. Based on this, screening tests will not be done in areas that have concentrations less than 0.0001 picocuries per cubic meter.

A.2 RISK-BASED SITING METHODOLOGY FOR SCREENING TEST SITES

The examination of screening test sites based on risk must take into account the detection limit of the wind tunnel. The detection limit is based on the mass of soil collected on the filter paper.

Based on the amount of mass collected on the filter paper, calculations have been performed to estimate a potentially significant risk from resuspended soil inhalation.

Particulate concentration of the sampled air (C_O) that can be pulled through a filter is expressed as:

$$C_D = \frac{m}{Qt} \tag{1}$$

where:

C_D = particulate air concentration (grams per cubic meter)
m = mass collected on filter paper (grams)
Q = rate of air flowing through the filter paper (cubic meters per minute)
t = time the air is sampled (minutes)

Using the assumption that the amount of contamination in the soil on the ground is the same as the amount of concentration in the resuspended soil, the concentration of plutonium in the sampled air (C_C) can be calculated as:

$$C_C = X \cdot C_D \tag{2}$$

where:

C_C = concentration of plutonium in the sampled air (picocuries per cubic meter)
X = contamination of soil and resuspended material (picocuries per gram)

Substituting equation (1) into (2):

$$C_C = X \cdot \frac{m}{Qt} \tag{3}$$

Solving for X, equation (3) becomes:

$$X = C_C \cdot \frac{Qt}{m} \tag{4}$$

The contamination level of soil and resuspended material (X) can be calculated based on the following:

Q = 1 cubic meter, the sampling rate of the wind tunnel
m = 0.003 grams (3 milligrams), the mass collected on the filter equals the detection unit
t = 30 minutes, the time most of the resuspended material will be exhausted, based on past experience
C_C = 0.0001 picocuries per cubic meter, the concentration of plutonium that triggers a risk of 1×10^{-6}

then:

$$X = (0.0001)\ \frac{(1)\ (30)}{(0.003)} = 1.0 \text{ picocurie per gram} \qquad (5)$$

Based on the above assumptions and testing conditions, tests should be done only on areas where soil contamination is 1.0 picocuries per gram or higher. For this reason, terrestrial sampling has been limited to areas of known higher contamination.

A.3 WIND TUNNEL STUDY TECHNICAL REQUIREMENTS/EXCEPTIONS

A.3.1 Sampling Equipment

The Midwest Research Institute (MRI) portable pull-through wind tunnel, as described in the "Air/Superfund National Technical Guidance Study Series, Volume II, Estimates of Baseline Air Emissions at Superfund Sites," is the device that will be used in performing the proposed field studies. Therefore, there will be no need for determination of equivalency because the MRI portable wind tunnel is the reference wind tunnel. The MRI portable wind tunnel (Figure A-1) features all of the contract-specific design and operating characteristics, including the equipment for extracting isokinetic samples of wind-generated particulate for mass and particle size determination. It has its own power source in the form of a gasoline engine with direct mechanical linkage to the primary blower, which drives the air flow through the tunnel.

In operating the wind tunnel, the open-floored test section is placed directly over the surface to be tested. Air is drawn through the tunnel at controlled velocities. The exit airstream from the test section passes through a circular duct fitted with a sampling probe fitted near the downstream end. Air is drawn through the probe by a high-volume sampling train. A high-volume ambient air sampler is operated near the inlet of the wind tunnel to provide for measurement and subtraction of the contribution of the background particulate level. This technique provides for the precise study of a wind erosion process on specific test surfaces, with minimal interference from background sources.

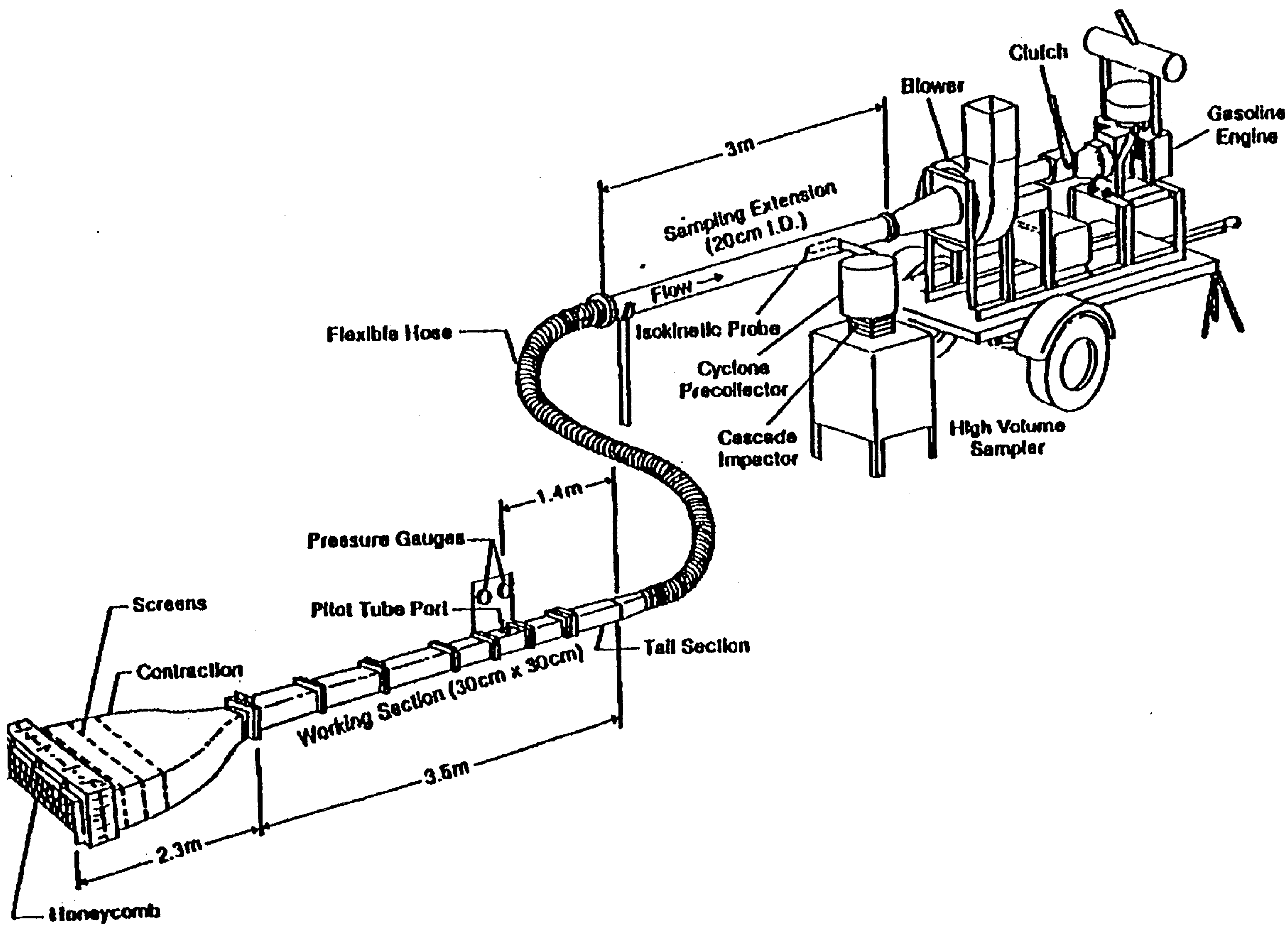


Figure A-1
MRI WIND TUNNEL

DRAWN BY	Douville 09/29/92	CHECKED BY	[illegible] 4/2/93	DRAWING NUMBER	RF1073
		APPROVED BY	[illegible] 4/2/93		

A high-volume cascade impactor with glass fiber impaction substrates, commonly used to measure mass size distribution of an atmospheric particulate, provides for the sizing of fugitive particulate emissions. A cyclone preseparator (Figure A-2) is used to remove coarse particles that would otherwise be subject to particulate bounce within the impactor, causing fine particle bias. The sampling intake is pointed into the air stream, and the sampling velocity is adjusted to the approach air speed by fitting the intake with a nozzle of appropriate size.

The use of the cyclone precollector ahead of the Sierra Andersen Slotted Cascade Impactor is critical to preventing substantial particle bounce and the associated biases in the measured size distribution. At the 20 acfm flow rate, the cyclone has a cutpoint of approximately 15 μmA, based on laboratory calibration. In addition, it has been found that the use of greased glass fiber substrates further mitigates against residual particle bounce and provides for direct gravimetric analysis of the particulate catches without the need to improve and separate them from the substrates.

The wind tunnel method relies on a straightforward mass balance technique for calculation of emission rate. By sampling under light ambient wind conditions, background interferences from upwind erosion sources can be avoided.

A.3.2 Performance Characteristics

The wind tunnel consists of a two-dimensional 5:1 contraction section, an open-floored test section, and a roughly conical diffuser. The larger test area of this tunnel (30 cm x 3.5 m) provides for its use on rougher surfaces. The tunnel centerline air flow is adjustable up to an approximate maximum speed of nearly 19 m/s (40 mph), as measured by a pitot tube at the downstream end of the test section.

Although the portable wind tunnel does not measure the larger scales of turbulent motion found in the atmosphere, the turbulent boundary layer formed within the tunnel simulates the smaller scales of atmospheric turbulence. It is the smaller scale turbulence that penetrates the wind flow in direct

DRAWN BY	Douville 09/29/92
CHECKED BY	4/2/93
APPROVED BY	4/12/93
DRAWING NUMBER	RF1072

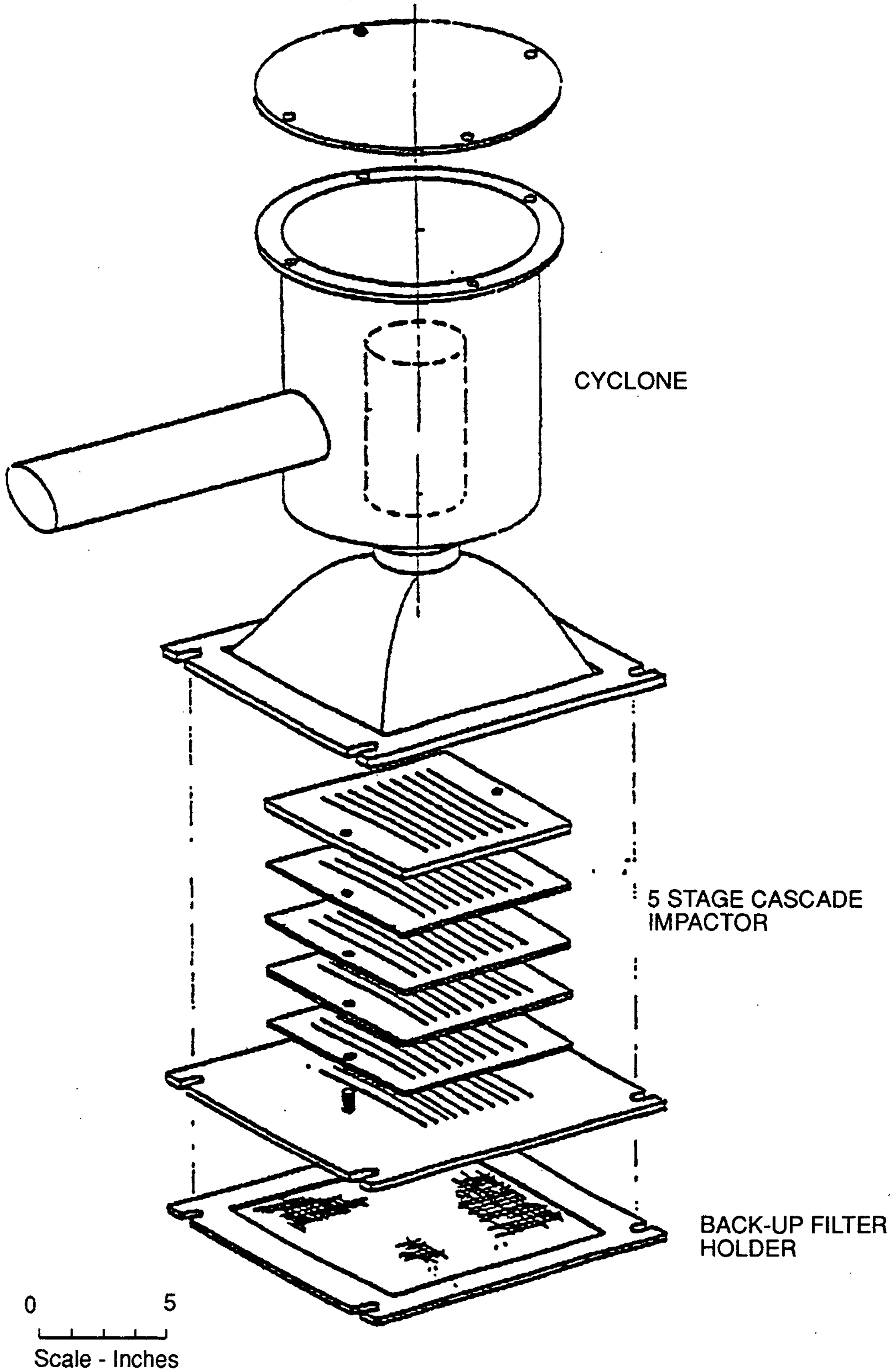


Figure A-2
CYCLONE PRESEPARATOR

contact with the erodible surface and contributes to the particulate entrainment mechanisms.

The wind speed profile near the test surface (tunnel floor) and the walls of the tunnel has been shown to follow a logarithmic distribution.

$$u\ (z) = \frac{u^*}{0.4} \ln \frac{Z}{Z_o} \tag{6}$$

where:

u = wind speed, cm/s
u^* = friction velocity, cm/s
Z = height above test surface, cm
Z_o = roughness height, cm

The friction velocity, which is a measure of wind shear at the erodible surface, characterizes the capacity of the wind to cause particle movement. As indicated from Equation (6), the wind velocity at any fixed height above the surface (but below the centerline of the wind tunnel) is proportional to the friction velocity.

The height of roughness for each test surface is determined by the extrapolation of the wind speed profile near the surface to $z=0$. A roughness height of 6×10^{-4} cm is used for the plexiglass walls and ceiling of the tunnel. Integration of the wind speed distribution over the cross-sectional area of the tunnel (30.5 cm x 30.5 cm) yields the volumetric flow rate through the tunnel for a specific set of test conditions.

An emissions sampling module provides for extraction and aerodynamic sizing of particulate emissions generated by wind erosion. The sampling module is located between the tunnel outlet hose and the fan inlet. The particulate sampling train, which is operated at 25 to 43 m^3/hr (15 to 25 cfm), consists of a tapered probe, cyclone precollector, parallel slot cascade impactor, back-up filter, and high-volume motor. Interchangeable probe tips are sized for isokinetic sampling.

A pitot tube is used to measure the centerline wind speed in the sampling duct at the point where the sampling probe is installed. Because the ratio of the centerline wind speed in the sampling duct to the centerline wind speed in the test section is independent of flow rate, the ratio can be used to determine isokinetic sampling conditions for any flow rate in the tunnel.

A portable high-volume air sampler with an open-faced filter is operated on top of the tunnel inlet section to measure background dust levels. The filter is vertically oriented parallel to the tunnel inlet face.

A.3.3 Sampling Procedure

Prior to each test series, the test section of the tunnel is placed directly on the selected test surface. Care is taken not to disturb any natural crust that might be present. Location of a suitable test surface is aided by the fact that the test surfaces tend to be large, relatively flat areas. To prevent air infiltration under the sides of the open-floored section, the rubber skirts, which are attached to the bottom edges of the tunnel sides, are stretched out on the surface adjacent to the test surface and covered with aggregate material transferred from the surface points further away.

With the tunnel in place, the airflow is gradually increased up to the threshold for the onset of wind erosion, as determined by visual observation of migration of coarse particle movement, and then slightly reduced. At the subthreshold flow, a wind speed profile is measured and a roughness height is determined. The measured roughness height allows for conversion of the tunnel centerline wind speed to the equivalent wind speed at a standard 10-meter height using the logarithmic wind speed profile.

Sampling begins just after the tunnel wind speed reaches the first prescribed super-threshold level corresponding to the mean of a standard wind speed range corrected to a height of 10 meters. After a 10-minute sampling period, the flow is ceased and the particulate catches are removed from the settling chamber, cyclone, impaction substrates (optional), back-up filter, and supplementary high-volume filters. Then, with the tunnel in the same position, testing is conducted separately at the same flow rate to determine whether the erosion rate is decaying in the manner of a "limited reservoir" surface. Again, with the tunnel in the same position, testing is conducted at the second (and third) flow rates. Additional tests of the same surface may be performed at successively higher levels up to the flow capacity of the tunnel.

At the end of each test, the sampling train is disassembled and taken to the field instrument van, and the collected samples of dust emissions are carefully transferred to protective containers. High-volume filters and impaction substrates are folded and placed in individual protective envelopes. Dust collected on the interior surfaces of the sampling probe is rinsed with distilled water into separate glass jars. The dust is then transferred from the cyclone precollector in the same manner.

Dust samples from the field tests are returned to the laboratory for gravimetric analysis. Glass fiber filters and impaction substrates are conditioned at a constant temperature and relative humidity for 24 hours prior to weighing (the same conditioning procedure as used before taring). Water washes from the sampling probe and cyclone precollector are filtered, after which the tared filters are dried, conditioned at constant humidity, and reweighed.

The raw test data that are recorded include the following:

- Site code and description
- Run number and type of test
- Test date, start time, and sampling duration
- Operating wind speed at tunnel centerline
- Threshold wind speed at tunnel centerline, and
- Ambient meteorology (wind speed and direction, temperature, and relative humidity)

A.3.4 Test Results and Interpretation

Because wind erosion is an avalanching process, it is reasonable to assume that the loss rate from the surface is proportional to the amount of erodible material remaining:

$$\frac{dM}{dt} = Kt \qquad (7)$$

where:

m = quantity of erodible material present on the surface at any time, g/m^2
k = constant, s^{-1}
t = cumulative erosion time, s

Integration of Equation (7) yields:

$$M = M_o\, e^{-Kt} \qquad (8)$$

where:

M_o = erosion potential, for example, quantity of erodible material present on the surface before the onset of erosion, g/m^2

Consistent with Equation (7), the erosion potential at a given wind speed may be calculated from the losses of erodible material from the test surface for two erosion times:

$$\frac{\ln\left[\dfrac{M_o - L_1}{M_o}\right]}{\ln\left[\dfrac{M_o - L_2}{M_o}\right]} = \frac{t_1}{t_2} \qquad (9)$$

where:

L_1 = loss during time period 0 to t_1, g/m^2

L_2 = loss during time period 0 to t^2, g/m^2

The loss of erodible material (g/m^3) which occurs during a test is calculated as follows:

$$L = \frac{CQt}{A} \tag{10}$$

where:

C = average particulate concentration in tunnel exit stream (after subtraction of inlet concentration), g/m^3
Q = tunnel flow rate, m^3/s
A = exposed test surface area = 0.918 m^2

An alternative procedure is required to calculate erosion potential from Equation (10) after the subtraction of two cumulative loss values and erosion times obtained from back-to-back testing of the same surface at the specified wind speed.

Whenever a surface is tested at sequentially increasing wind speeds, the measured losses from lower speeds are added to the losses from the next higher speeds, and so on. This reflects the hypothesis that, if lower speeds had not been tested beforehand, correspondingly greater losses would have occurred at the higher speeds.

The calculated test results include:

- Roughness height
- Frictional velocity
- Equivalent wind speed at reference 10-meter height
- Average emission rate, and
- Erosion potential (for "limited reservoir" surfaces)

A.3.5 Detection Limit and Precision of Portable Wind Tunnel Method

Presented below are calculations of the detection limit and precision of the portable wind tunnel for the measurement of PM-10 emission rate. These calculations are based on the following equation for emission rate of airborne particles generated by wind erosion of the test surface within the wind tunnel:

$$e = \frac{QC_n}{A} \tag{11}$$

where:

e	=	particulate emission rate, g/m^2-sec
Q	=	tunnel flow rate, m^3/sec
C_n	=	net particulate concentration in tunnel effluent, g/m^3
A	=	exposed test surface area = 0.918 m^2

The net concentration, in turn, is given by:

$$Q_n = C_e - C_b \tag{12}$$

where:

C_e	=	particulate concentration in tunnel effluent (g/m^3)
C_b	=	the background concentration in the tunnel makeup air (g/m^3)

A.3.5.1 Detection Limit

For the proposed screening studies of erodible surfaces, the method detection limit is dominated by the detection limit for particulate mass (PM-10) on the 8-inch by 10-inch back-up filter below the cyclone preseparator in the lackinetic sampling train. The other parameters in Equation 11 around fixed at values well above their respective detection limits, as follows:

Q = tunnel effluent flow rate = 10 to 60 m^3/min
Q_s = sample flow rate = 0.933 m^3/min) (40 ACFM)
A = exposed test surface area = 0.918 m^2

Because the sample stream is representative of the tunnel effluent, the net PM-10 concentration in the tunnel effluent is given by:

$$C_n = C_s - C_b = \frac{M_s}{Q_s t} - C_b \tag{13}$$

where:

C_s = PM-10 concentration in sample stream (g/m^3)
C_b = the background (tunnel make-up air) PM-10 concentration (g/m^3)
M_s = PM-10 mass on the back-up filter of the sampling train (g)
Q_s = sample flow rate = 0.933 m^3/min (40 ACFM)
t = sampling duration (min)

The detection limit for particular mass on an 8-inch by 10-inch glass fiber filter is approximately 3 mg. This value is three time the typical standard deviation of blank values (1.1 mg).

Thus, the detection limit for the PM-10 concentration in the sample stream, based on a 3-minute minimum sampling time, is given by:

$$C_s = \frac{M_s}{Q_s t} = \frac{3\ \text{mg}}{(0.933\ \text{m}^3/\text{min})(3\ \text{min})} \tag{14}$$

$$\approx 1\ \text{mg/m}^3$$

Because the background concentration (C_b) is usually negligible compared to 1 mg/m^3, the detection limit of the net PM-10 concentration in the tunnel effluent (C_n) is also approximately 1 mg/m^3.

Finally, Equations 11 and 12 can be used to determine the minimum detectable PM-10 emission rate (e_L) as follows:

$$\begin{aligned} e_L &= \frac{QC_n}{A} = \frac{QM_s}{AQ_s t} \\ &= \frac{(Q\text{m}^3/\text{min}) \times (3\ \text{mg})}{(0.818\ \text{m}^3) \times (0.933\ \text{m}^3/\text{min}) \times (t\ \text{min})} \\ &= 3.5\ \frac{Q}{t}\ \frac{\text{mg}}{\text{m}^3 - \text{min}} \end{aligned} \tag{15}$$

For a typical flow rate of 32 m^3/min (corresponding to a tunnel centerline wind speed of 9 m/s) and a minimum sampling time of 9 min.

$$e_L = 37 \frac{\text{mg}}{\text{m}^2\text{-min}} = 0.0006\ \frac{\text{g}}{\text{m}^2\text{-s}} \tag{16}$$

For the comprehensive tests of erodible surfaces, the minimum detectable MP-10 emission role will be approximately six times higher than the values presented earlier for screening tests. This reflects the use of up to five impactor substrates plus the back-up filter in subdividing the PM-10 mass. As a first approximation, it is assumed that the particulate loading is distributed evenly over all six collection media.

A.3.5.2 Method Precision

At very low PM-10 loadings (near the detection limit), the precision of the method is limited by the uncertainty in gravimetric determination of the PM-10 mass collected on the back-up filter of the particulate sampling train. This can be estimated in terms of the relative standard deviation (RSD)[1] of the PM-10 mass determination at the detection limit $L = 3\sigma$

$$RSD = \frac{\sigma}{L} = \frac{\sigma}{3\theta} = 33\% \qquad (16)$$

This value decreases with increasing filter loadings until the filter becomes overloaded. When the latter condition occurs, the uncertainty in gravimetric analysis is limited by the loss in sample during the filter preparation process (transfer, conditioning, and weighing).

In the intermediate range of filter loading, the measurement uncertainty is dominated by the errors in flow measurement, as represented by an RSD of approximately 5 percent. However, this presumes that it is possible at the start of a test to achieve a step change in tunnel flow rate from a subthreshold value to the desired set value.

In point of fact, the manual ramp-up process introduces random differences from one test to the next. Because the emission rate is highly sensitive to wind speed above the threshold value,the potential "ramp-up" error increases at the higher set flows. It is estimated that this error is represented by an RSD of about 20 percent.

[1]The relative standard deviation is simply the standard deviation divided by the mean value.

It should be noted that the wind tunnel method precision can be determined quantitatively only by replicate testing of identical erodible material. Such conditions generally cannot be found in the field, so operation of the wind tunnel in a laboratory environment is required. Triplicate MFH tests of a sand/salt mixture in the laboratory, with a reduced scale wind tunnel, showed a slightly higher RSD (25 percent) for PM-10 emission rate, but somewhat variable humidity conditions over the 3-day test period probably affected the day-to-day erodibility of the test mixture.

A.4 QUALITY ASSURANCE PROCEDURES

The pre-test activities include calibration of the BGI orifice calibrator and preweighing of the glass fiber filters and impactor substrates.

The Roots Meter is the primary volumetric standard and the BGI office calibrator is the secondary standard for calibration of hi-vol sampler flow rates. The Roots Meter is calibrated and traceable to a NIST standard by the manufacturer on an annual basis. Before going to the field, the BGI is first checked to assure that the orifice has not been damaged. If undamaged, the orifice is then calibrated using the procedure specified in the Quality Assurance Handbook (EPA, 1977) and SOP EET-620 (Appendix B). In the field, an orifice meter (BGI orifice) is used to calibrate the flow rate of each hi-vol sampler.

The second pre-test activity is the preparation of the filters for use in the field. In this preparation, the filters are weighed under stable temperature and humidity conditions as described in MRI-SOP EET-610 (Appendix B). After they are weighed and have passed audit weighing (described in SOP EET-610), the filters are packaged in glassine envelopes and shipped to the field.

Whenever practical, all data collected in the study will be entered directly into bound notebooks. Standard data forms are to be used when direct notebook entry is impractical. All data are to be recorded using permanent ink and signed and dated by sampling personnel. Notebooks and data forms are to be inspected for completeness and accuracy by the appropriate field supervisor at the end of each test.

To maintain sample integrity, the following procedures will be used:

- Each filter will be issued a unique identification number which will be printed on the sample container.

- The sample number will be recorded in a sample logbook along with the date the sample is obtained. The sample number will be coded to indicate the sample location and test series.

- Other pertinent information to be recorded include a short description of sample type or location, storage location, condition of sample, any special instructions, and signatures of personnel who receive the sample for analysis.

- In order to maintain custody, all sample transfers will be recorded in a notebook or on forms. The following information will be recorded: the assigned sample codes, date of transfer, location of storage site, and the name of the person initiating and accepting the transfer.

After the particulate matter samples have been collected and returned from the field, the filters will be placed back in the gravimetric laboratory and allowed to come to equilibrium as required by procedure SOP EET-610. Each filter will be weighed, allowed to return to equilibrium for an additional 24 hours, and then 10 percent of the filters are reweighed. If a filter fails the ±2.0-mg audit criterion, the entire lot will be allowed to set in the gravimetric laboratory an additional 24 hours and then reweighed as required by SOP EET-610. The tare and first weight criteria (Table 3-2) are based on an internal MRI study conducted in the early 1980s of several hundred 8- x 10-inch glass fiber filters used in exposure-profiling studies.

The analytical procedures used for this project are formal EPA procedures that have been through several layers of validation substantiating the performance of the method. The verification of these procedures to the criteria established for this project will be performed using internal quality control as the indicator for the integrity of the analytical system.

The validation of the data-handling systems or computer systems will be performed using a known set of control data. The control data are entered into the data handling system and the results will be compared to previous results from similar systems. If the results for the control set of data are the same as previously calculated by the data system, the system will be considered validated. If the results are different than the control data set, the system will have failed the validation process and must be reviewed and corrected. The corrected data system will be validated with the control data set as was done previously. The corrective actions on the data system will be documented including the revalidation of the system.

A.4.1 Quality Assurance Performance and Systems Audits

For this project, the performance of the data collection procedures will be evaluated by the quality control procedures. The assessment of the internal quality control data with respect to the DQO criteria will provide a realistic view of data quality. The quality control data that will be reviewed will be:

- Gravimetric audit weighing for the assessment of the particulate data

- Calibration criterion checks to determine the acceptability of the calibration curves generated for each analytical procedure

- Internal QC checks to assess the analytical system

All documented work will be reviewed by the project leader for completeness.

Appendix B

MRI STANDARD OPERATING PROCEDURES FOR FILTER WEIGHING (SOP EET-610) AND BGI ORIFICE CALIBRATION (SOP EET-620)

MIDWEST RESEARCH INSTITUTE STANDARD OPERATING PROCEDURES		Code No.: EET-610 Revision: 1 Date: 02/20/92 Page: 1 of 4
ENGINEERING AND ENVIRONMENTAL TECHNOLOGY DEPARTMENT	Approved by: Andrea C Hell for T.L. Sagonelli Senior Vice President Kansas City Operations	
FILTER WEIGHING	Approved and Released by: Eugene E Dickerson Manager, Quality Assurance	

I. Weigh Room Conditioning

Filter equilibration and weighing are performed in the weigh laboratory (106N). The temperature and relative humidity of this laboratory are maintained at 23° ± 1°C and 45 ± 5 percent, respectively.

The environmental control system in this lab is monitored by a Weathertronics Model 5021 hygrothermograph. Each week the chart on this instrument is to be changed. At this time a motorized psychrometer is used to verify the temperature and relative humidity indicated by the hygrothermograph. These values should be recorded on the new and old chart with the date, time, and initial of the person performing the work. The psychrometer thermometers are to be calibrated annually against an NBS traceable thermometer. Adjust the pens of the hygrothermograph to match the actual temperature and humidity if necessary. If the room conditions are not within the allowable limits, under the direction of the lab manager, adjust the wall controls.

II. Filter Numbering

Each filter is imprinted with a unique seven-digit number. These numbers are imprinted on the filter with the stamp located in the weigh room.

Example of Filter Numbering System:	81	5	0	001
	year	project	filter type	number

Type	Vendor	Size	Composition
1	Sierra	8 x 10	Glass fiber type A
2	Gelman	8 x 10	Glass fiber type A, spectrograde
3	Gelman	8 x 10	Glass fiber type AE
4	Gelman	8 x 10	Glass fiber type E
5	Ghia	37 mm	Teflon
6	Millipore	47 mm	Glass fiber (wash)
7	Gelman-Sierra	37 mm	Glass fiber type AE (Dichot)
8	Sierra	4 x 5	Glass fiber (greased)
9	Sierra	4 x 5	Glass fiber (nongreased)
0	Whatman	11 cm	Glass fiber (wash)

III. Filter Equilibration

Prior to the initial weighing, equilibrate the filters for 24 hr at constant temperature and humidity in the weigh room. Place each numbered filter in an identically numbered file folder, then set the folder in a rack. Two folders per slot are permitted.

Record filter equilibration data on the special data form located in the weighing room quality assurance book.

Example:

Filter Equilibration Data

Equilibration Period				Temperature (°C)				Relative Humidity (%)				
End		Begin					Meets				Meets	
Date	Time	Date	Time	Max.	Min.	Avg.	Q.A. ?	Max.	Min.	Avg.	Q.A. ?	By
1/11/88	0900	1/10/88	0900	23.2	23.0	23.1	Yes	45.6	45.2	45.4	Yes	GS

Balance Check

The balance is calibrated on an annual basis, however, it must be checked against NBS traceable (class S) weights before each day's weighing. For the Mettler balances, an absolute difference of 0.5 mg or less from the class S weights is permitted. Record balance check data on the form located in the weighing room quality assurance book.

Example:

Balance Check Data

		Balance Data		Calibration Data				
Date	Time	Balance Type	MRI I.D. No.	Class S Weight (mg)	Balance Reading (mg)	Difference (mg)	Meets Q.A.?	By
1/11/88	0900	Mettler	7216	1,000.00	1,000.00	0.00	Yes	GS
				3,000.00	2999.90	0.10	Yes	GS
				5,000.00	4999.85	0.15	Yes	GS

Check the balance at least once during every 4 hr of weighing. Failure to reproduce the check weight within ±0.5 mg will initiate reweighing of filters processed since the last check weighing.

Tare Weighing

After 24 hr of equilibration and the balance check, filters may be tare-weighed. Record data in the filter analysis log. Place the filters back in the rack and allow them to remain in the weigh room for another 24 hr, after which a second analyst will reweigh them. If a filter cannot pass audit, reweigh it.

Example:

	First Weigh			Audit					Reweigh		
Filter Number	Weight (mg)	By	Date	Weight (mg)	Difference (mg)	Meets Q.A.?	By	Date	Weight (mg)	By	Date
88S1001	4322.50	GS	1/11/88	4322.40	0.10	Yes	BM	1/12/88			
002	4356.35	↓	↓	4356.30	0.05	↓	↓	↓			

Tare audit limits are:

MRI-OTBR16-01.QAP

Filter Type	Limit (mg)
8 x 10 glass fiber	1.00
4 x 5 glass fiber	0.50
47-mm glass fiber	0.10
37-mm glass fiber	0.10
37-mm Teflon	0.10
37-mm mixed cellulose ester	0.05
11-cm glass fiber	0.25
Andersen sampler	0.15
Andersen backup (2 1/2-in diameter)	0.20
Glass fiber thimble	0.75

Final Weighing

Upon return to the lab, equilibrate exposed filters for 24 hr as for preweighing. After the balance check they may be weighed. Again, record all equilibration and balance check data on the forms in the weigh room. Record sample weight data in the filter analysis log. Place the samples back in the racks for another 24 hr after which a second analyst will reweigh 10% of them. If any sample does not pass audit, reweigh all samples in that lot. If a filter passes audit, use its initial weight. If a filter fails audit, the last reweigh value is to be used.

Example:

Filter Number	First Weigh			Audit					Reweigh		
	Weight (mg)	By	Date	Weight (mg)	Difference (mg)	Meets Q.A.?	By	Date	Weight (mg)	By	Date
885100l	438575	GS	1/18/88								
002	445245	↓	↓	445020	0.25	Yes	BH	1/19/88			

Final audit limits are:

Filter Type	Limit (mg)
8 x 10 glass fiber	2.00
4 x 5 glass fiber	1.00
47-mm glass fiber	0.20
37-mm glass fiber	0.20
37-mm Teflon	0.20
37-mm mixed cellulose ester	0.10
11-cm glass fiber	2.00
Andersen sampler	0.30
Andersen backup (2 1/2-in diameter)	0.40
Glass fiber thimble	1.50

1. Attach the orifice calibrator to the top of the rootsmeter.

2. Attach the negative pressure port of a 10-in incline water manometer to the orifice calibrator with rubber tubing. Vent the other port to the atmosphere. Level and zero the manometer.

3. Attach one port of a 30-in U-tube water manometer to the top pressure tap of the rootsmeter. Vent the other port to the atmosphere.

4. Plug the bottom pressure tap of the rootsmeter.

5. Record the date, barometric pressure in inches of mercury (Pb), ambient temperature in °C (Tc), orifice serial number, MRI tag number, and your name on the calibration data form.

6. Use a variac to control the flow through the rootsmeter. Adjust the flow until ΔPo (pressure drop across the calibration orifice) is 1 in of water, as measured on the incline manometer.

7. Allow the system to become stable at that flow rate.

8. Start a stopwatch as the volume indicator on the rootsmeter passes a distinguishable reference point.

9. While the stopwatch is running, check ΔPo occasionally and adjust the variac to compensate for drift.

10. After 1 m^3 has accumulated on the rootsmeter beyond the point at which the stopwatch began, record ΔPr (pressure drop across the rootsmeter) as indicated on the U-tube manometer.

11. When 2 m^3 (ΔV) have accumulated on the rootsmeter volume indicator, stop the stopwatch. Record the elapsed time in seconds (ΔT).

12. Perform steps 8-11 three times. Average the three values for ΔT and for ΔPr and record the averages on the data form.

13. Using the values for Tc, Pb, ΔV, the average values for ΔT and ΔPr, and the equations on the calibration calculations data sheets, calculate the actual flow rate (acfm) and the standard flow rate (scfm). Record these flow rates on the data form.

14. Repeat steps 6-13 for each of the following points:

ΔPo	ΔV
2.0	3
3.0	3
4.0	4
5.0	4
6.0	5
7.0	5
8.0	5

15. Plot the resulting calibration curve (ΔPo vs. scfm).

Equipment List

Orifice calibrator
Rootsmeter
Variac
10-in incline water manometer
30-in U-tube water manometer
Rubber tubing
Stopwatch

Calibration Data Form for SGI Orifice

Date ____________ Pb ____________ Tc ____________

Name ____________ Serial # ____________ MRI Tag # ____________

ΔPo (in. of H_2O)	ΔV (m^3)	ΔPr (in. of H_2O)	ΔT (sec)	Actual Flow Rate (acfm)	Standard Flow Rate (scfm)
1.0	2				
	2				
	2				
	Avg.				
2.0	3				
	3				
	3				
	Avg.				
3.0	3				
	3				
	3				
	Avg.				
4.0	4				
	4				
	4				
	Avg.				
5.0	4				
	4				
	4				
	Avg.				
6.0	5				
	5				
	5				
	Avg.				
7.0	5				
	5				
	5				
	Avg.				
8.0	5				
	5				
	5				
	Avg.				

Calibration Calculations for BGI Orifice

Date ______________ Pb ________________ Tc ____________________

Name ______________ Serial # __________ MRI Tag # __________

$$Tk = \text{temperature in } ^\circ K = Tc + 273.15$$

$$Vt = \text{volume transferred} = \frac{Pb - \frac{\Delta Pr}{13.6}}{Pb} \times \Delta V \times 35.31 \frac{ft^3}{m^3}$$

$$acfm = \frac{Vt}{\Delta T} \times 60 \frac{sec}{min}$$

$$scfm = acfm \times \frac{298.15K}{Tk} \times \frac{Pb}{29.92 \text{ in. Hg}}$$

For $\Delta Po = 1.0$,

$$Vt = \frac{\quad - \frac{\quad}{13.6}}{\quad} \times 2\ m^3 \times 35.31 \frac{ft^3}{m^3} = \qquad ft^3$$

$$acfm = \frac{\quad ft^3}{\quad sec} \times 60 \frac{sec}{min} = \qquad \frac{ft^3}{min}$$

$$scfm = \qquad \frac{ft^3}{min} \times \frac{298.15K}{\quad K} \times \frac{\quad in.\ Hg}{29.92\ in.\ Hg} = \qquad \frac{ft^3}{min}$$

For $\Delta Po = 2.0$,

$$Vt = \frac{\quad - \frac{\quad}{13.6}}{\quad} \times 3\ m^3 \times 35.31 \frac{ft^3}{m^3} = \qquad ft^3$$

$$acfm = \frac{\quad ft^3}{\quad sec} \times 60 \frac{sec}{min} = \qquad \frac{ft^3}{min}$$

$$scfm = \qquad \frac{ft^3}{min} \times \frac{298.15K}{\quad K} \times \frac{\quad in.\ Hg}{29.92\ in.\ Hg} = \qquad \frac{ft^3}{min}$$

MRI-CTSVR12-01.CAP

For ΔPo = 3.0,

$$Vt = \underline{\qquad\qquad} \sqrt{13.6} \times 3\ m^3 \times 35.31\ \frac{ft^3}{m^3} = \qquad ft^3$$

$$acfm = \underline{\qquad\quad} \frac{ft^3}{sec} \times 60\ \frac{sec}{min} = \qquad \frac{ft^3}{min}$$

$$scfm = \qquad \frac{ft^3}{min} \times \frac{298.15K}{\underline{\quad} K} \times \frac{\underline{\quad} in.\ Hg}{29.92\ in.\ Hg} = \qquad \frac{ft^3}{min}$$

For ΔPo = 4.0,

$$Vt = \underline{\qquad\qquad} \sqrt{13.6} \times 4\ m^3 \times 35.31\ \frac{ft^3}{m^3} = \qquad ft^3$$

$$acfm = \underline{\qquad\quad} \frac{ft^3}{sec} \times 60\ \frac{sec}{min} = \qquad \frac{ft^3}{min}$$

$$scfm = \qquad \frac{ft^3}{min} \times \frac{298.15K}{\underline{\quad} K} \times \frac{\underline{\quad} in.\ Hg}{29.92\ in.\ Hg} = \qquad \frac{ft^3}{min}$$

For ΔPo = 5.0,

$$Vt = \underline{\qquad\qquad} \sqrt{13.6} \times 4\ m^3 \times 35.31\ \frac{ft^3}{m^3} = \qquad ft^3$$

$$acfm = \underline{\qquad\quad} \frac{ft^3}{sec} \times 60\ \frac{sec}{min} = \qquad \frac{ft^3}{min}.$$

$$scfm = \qquad \frac{ft^3}{min} \times \frac{298.15K}{\underline{\quad} K} \times \frac{\underline{\quad} in.\ Hg}{29.92\ in.\ Hg} = \qquad \frac{ft^3}{min}$$

For ΔPo = 6.0,

$$Vt = \underline{\qquad\qquad {}^{-}\overline{13.6}} \times 5\ m^3 \times 35.31\ \frac{ft^3}{m^3} = \qquad ft^3$$

$$acfm = \underline{\qquad\qquad} \frac{ft^3}{sec} \times 60\ \frac{sec}{min} = \qquad \frac{ft^3}{min}$$

$$scfm = \qquad \frac{ft^3}{min} \times \frac{298.15K}{K} \times \frac{in.\ Hg}{29.92\ in.\ Hg} = \qquad \frac{ft^3}{min}$$

For ΔPo = 7.0,

$$Vt = \underline{\qquad\qquad {}^{-}\overline{13.6}} \times 5\ m^3 \times 35.31\ \frac{ft^3}{m^3} = \qquad ft^3$$

$$acfm = \underline{\qquad\qquad} \frac{ft^3}{sec} \times 60\ \frac{sec}{min} = \qquad \frac{ft^3}{min}$$

$$scfm = \qquad \frac{ft^3}{min} \times \frac{298.15K}{K} \times \frac{in.\ Hg}{29.92\ in.\ Hg} = \qquad \frac{ft^3}{min}$$

For ΔPo = 8.0,

$$Vt = \underline{\qquad\qquad {}^{-}\overline{13.6}} \times 5\ m^3 \times 35.31\ \frac{ft^3}{m^3} = \qquad ft^3$$

$$acfm = \underline{\qquad\qquad} \frac{ft^3}{sec} \times 60\ \frac{sec}{min} = \qquad \frac{ft^3}{min}$$

$$scfm = \qquad \frac{ft^3}{min} \times \frac{298.15K}{K} \times \frac{in.\ Hg}{29.92\ in.\ Hg} = \qquad \frac{ft^3}{min}$$

Figure 2-1

SOIL TRENCH LOCATIONS
OPERABLE UNIT 3, ROCKY FLATS PLANT

BASE MAPPING SOURCE: EG&G

DRAWN BY	M. CAMPBELL	CHECKED BY	[illegible signature]	4/1/93	DRAWING NUMBER RF0101
	03/26/93	APPROVED BY	[illegible signature]	4/1/93	

0181C021.DLV

0181c021.dlv

Figure 2-3
SEDIMENT SAMPLING LOCATIONS
OPERABLE UNIT 3, ROCKY FLATS PLANT

BASE MAPPING SOURCE: EG&G

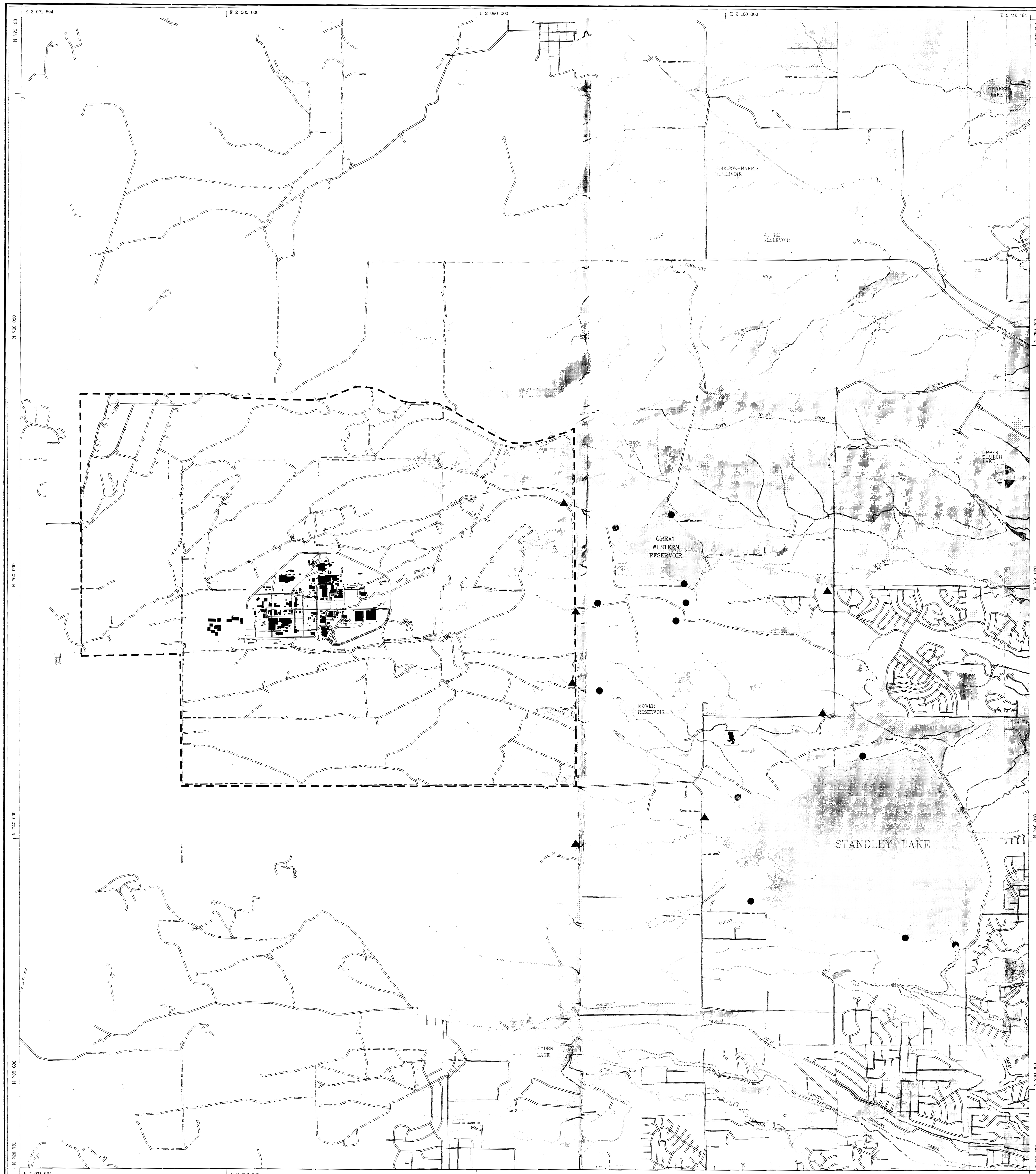
0181c023.dlv

DRAWN BY	M. CAMPBELL	CHECKED BY	[signature]	4/1/93	DRAWING NUMBER	RF0102
	03/29/93	APPROVED BY	[signature]	4/1/93		

0181C020.DLV

DRAWN BY	M. CAMPBELL 04/23/93	CHECKED BY		DRAWING NUMBER	RF0102
		APPROVED BY			

Figure 3-2
SOIL PLOT LOCATIONS
OPERABLE UNIT 3, ROCKY FLATS PLANT



U.S. Department of Energy

Rocky Flats Plant

Figure 3.3

OU3 Air Sampling Locations

Streams, ditches, and other drainage features

Lakes/ponds

Settlement agreement area

▲ RAAMP air sampling station

● MET tower

Ultra hi-vols.

● Wind tunnel location (shoreline)

● Wing tunnel location (terrestrial)

Raptor nesting site

Data Source: Road network and Hydrography obtained from USGS digital line graphs (NAD27)

Mapscale = 1 : 24000
1 inch = 2000 feet

State Plane Coordinate Projection
Zone 3476

Prepared by:

EG&G ROCKY FLATS

Date: 4-5-93

RR060692